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It has taken two years and a half to convince the prosecuting officers of New York City that a mere error of judgment on the part of a signalman is not a crime for which he should go to state's prison. Cornelius A. Jackson, the signalman at Fifty-third street junction, on the Ninth Avenue Elevated road, who, on September 11, 1905, set the switch for the wrong track, was sentenced in the Court of General Sessions to five years' imprisonment; but the Appellate Division has now reversed that decision and set him free, holding that, as the signals (home and distant) showed, seasonably and plainly, which way the switch was set, the fault was the motorman's, not Jackson's. This, of course, is the only rational conclusion that could be reached by anyone conversant with all the facts. The movement of the train through the sharp curve leading to Fifty-third street at 25 miles an hour resulted in derailing one car and the death of a dozen passengers; and the officers of the law seemed to think that an exemplary punishment ought to be inflicted on some one, because of the magnitude of the disaster; though errors of a similar character (though not so disastrous) are no doubt committed in New York City every month. Paul Kelly, the motorman, had run away, so the whole force of public opinion, as represented by the legal department of the county, fell on Jackson. Kelly was followed, however, and after two years was caught and tried and is now in Sing Sing prison. Jackson's error consisted in leaving his post of duty for a minute or two (on account of illness, the court says), and leaving the switch and signals set for Fifty-third street. Probably he was breaking no vital rule for, as before stated, he left the signals properly set so that no motorman could excuse himself for not knowing that he was being directed to the sharp curve; but as trains follow one another every three or four minutes, or oftener, he should have allowed nothing but imperative necessity to take him away from his post until he knew which way the next approaching train was destined. To provide the utmost precaution, the signalman at a place like this should not leave his post without first setting the switch for the straight track, as a runaway on that track would be less dangerous than on the curve; but, as we have intimated, this extreme precaution probably was not prescribed by the rules. The essential trouble appears to have been that Kelly was inexperienced and incautious, having never run on this division except along the straight track; and that the signals could not be set to indicate at the same time "stop" for both routes; they were disks, always showing a clear track for either one or the other of the two routes. The trouble with the legal gentlemen appears to have been that they were unable to see the necessity, or even the probable reasonableness, of a rule by which a signalman may at any time on a minute's notice safely leave his post. This rule is vital, for without it the safety of thousands of trains every day would depend not only on the lives and the sanity of signalmen, but on their unerring judgment. But everybody, including the lawyers, apparently prefers the romantic notion that every signalman repeatedly every day holds a hundred passengers' lives in his hands.

Fifty passengers have been killed in Belgium, in one of the most spectacular train accidents that ever occurred in Europe. The cause of the disaster is not clearly reported, but it seems to have been carelessness in making repairs to a switch (interlocked) while the signals had not been set to notify trains to reduce their speed. Belgium is the home of the International Railroad Congress and its railroad practice ought to embody the sum of all wisdom. In this particular feature the best wisdom may be summarized, no doubt, in the prescription of very simple yet precise rules, and rigid inspection to see that such rules are carried out; and we have no reason to doubt that in this respect Belgium stands as high as any other country. The reader will recall three recent accidents to passenger trains in this country from the same cause, one at Philadelphia, one near New York, and one at Washington.* The first one was due to the mistake of a repairman in spiking a switch the wrong way; the speed of the passenger train had been reduced but not reduced enough; in the other two cases the error was made by a contractor's employee. Happily the disaster in each case was greatly mitigated by favorable circumstances. The task of enforcing perfectly safe rules in repair work is one of the most difficult in railroad operation; difficult because in so many situations the rules seem unnecessary. Not one time in a thousand does the competent repairman need any rules, for he knows, without being told, that the signals must be set at "stop" before he disturbs the track. The rules are made for the thousandth or ten-thousandth time, when, if using his own judgment, he may not take *all* the precautions necessary. Rules which men thus are liable constantly to look upon as refinements that are

*Philadelphia, December 19, 1904; New York, August 4, 1905; Washington, November 19, 1907.

worse than useless always have been and always will be hard to enforce. Still, the only lesson is to enforce them. The ideal enforcer of rules is the military officer who so trains, governs and inspects his men that he is fully prepared for the enemy every minute of the 24 hours; but our task is even harder than the soldier's because he sometimes *knows* that the enemy is five miles away, while our enemy is *always* in ambush. The carefully prepared rules of the signal department of the Lake Shore & Michigan Southern for the conduct of outdoor repairs were reprinted in the *Railroad Gazette* of August 18, 1905, and they furnish very interesting reading for every signal engineer or supervisor who is not absolutely sure that his stable doors are locked. The English Railway Clearing House rules require that when repairs are going on the distant signal shall be disconnected from the lever in the machine. For the guidance of enginemen in running through interlocking plants where some of the functions are out of service, and the switch rails have not been spiked, the best rule is for them to reduce their speed sufficiently to be able to see by looking at the rails where they are being led to, though at many places it is difficult to enforce it. This rule is not practicable at night; but another good rule is to require the repairers to have all switches spiked some time before dark.

NORTHERN SECURITIES AND THE NEW HAVEN.

The famous Northern Securities case fills 214 pages of the United States Law Reports but its records can be condensed to a few leading points. Certain stockholders of the Great Northern and Northern Pacific railroad companies, "with competing and substantially parallel lines from the Great Lakes and Mississippi river to the Pacific ocean" endeavored to combine them in a holding corporation, the Northern Securities Company of New Jersey. Suit was brought by the government against the combination under the anti-trust (Sherman) act of 1890, and, on appeal, the United States Supreme Court held that the combination was in violation of the law and was in restraint of interstate commerce. Four judges, Harlan, Brown, McKenna and Day, interpreted the Sherman act radically and applied it to contracts in restraint of trade whether "reasonable" or not. Judge Brewer, the fifth judge, held, in substance, that they must be unreasonable and affirmed individual investment rights; but held, in the particular case, that there was an unlawful combination of individuals in restraint of trade and concurred with the four judges named, thus making a majority of one. The four other judges, Chief Justice Fuller, White, Peckham and Holmes, dissented, holding that the ownership of stock in railroads "is not commerce at all," and that the law does not apply to suppression of competition "by fusion." Such in its essence and stripped of collateral branches was the Northern Securities decision. Its narrow margins and infirm base as a precedent, especially in view of future changes on the supreme bench, are obvious at a glance.

Broadly speaking the suit just brought by the federal government against the New York, New Haven & Hartford under the same anti-trust act lies along the same lines as that against the Northern Securities corporation. There are counts which could be lifted almost bodily from one complaint into the other. The general principles run parallel. In the New Haven, as in the earlier case, the question of the legal status of a holding company may also get into the suit before it ends; and there are other external similarities. But, in details, and in what may be called physical conditions of the two cases there are striking disparities. In the New Haven case there is, strictly speaking, no combination of stockholders to suppress competition and the original agency is an old and single corporation. The Northern Securities suit related to two long and parallel lines with intensive competition while, in the New Haven case, competition is distributive and in the nature of general monopoly slowly built up. The New Haven suit involves a vast system of street railways, some originally competitive, others purely lateral and feeders—and these trolleys, by the way, have, in corporate organization, been segregated to their states. This may affect the interstate question technically though the street railways are under "indirect" New Haven control. Why the marine properties of the New Haven are not named in the suit is one of the mysteries. Practically all of them are of an interstate character and of a nature to strengthen the federal suit. The omission of them is strong intrinsic evidence of the truth of the report of an original promise of the administration to exempt them. On the consistency of such federal action and attitude there need be no comment.

While so similar in the basic principles of law involved it will thus be seen that the New Haven suit is far more complicated than the case against the Northern Securities Company; and it is not simplified by the coincident suit of the state of Massachusetts against the defendant corporation, saying nothing of the question of ultimate disposal of the New Haven properties should the government win a case, in which success would in many respects be more serious than defeat.

But it is not on the technical phases of the suit that the mental vision of the intelligent citizen and man of affairs pauses long. Behind law and the courts there are railroad history and a resulting situation of the deepest import. The New Haven corporation typifies a natural and inexorable law of railroad development and railroad unity. It is a corporation 60 years old. Almost 40 years ago, with the absorption of the New Haven, Hartford & Springfield line, its record of consolidation began. Since then it has absorbed, in one form or another, not fewer than 50 transportation lines—railroad, street railway and marine. It has unified and expedited traffic. It has sustained and improved a host of weak subsidiary lines. Branch roads that were defective in public service conditions have been standardized. Its steam system as a whole, allowing for actual cost, improvements plowed in, and increased valuation has not only not been "watered" but has been desiccated. In the transition downward of freight rates it has, if due allowance be made for classification of traffic, surpassed both the Boston & Albany and the Boston & Maine. In passenger service it has been the only railroad corporation in the country to adopt *voluntarily* the two cents a mile rate upon its whole system. If it be rejoined that this was fiscal expediency on a system of great passenger density, the actual boon to the traveling public remains still as a truism. The corporation in the past has had sinister relations to legislation in Connecticut and Rhode Island, but they were much worse before the days of monopoly than since. It has taken in 1,400 miles of street railway, much of it in a high degree aqueous. But the policy was protective, the water had been turned on by state authority long before the street railways were acquired and, as related to absorbed parallels, the outcome has been the transfer of steam business to the street railways at lower fares and corresponding public benefit.

The question of the partial but serious disintegration of such a system, evolved in the same manner as other large railroad systems, is now at bar and the Northern Securities case has been transferred to New England. The suit is one that reaches through the years, it must pass from one federal administration into another and the courts may or may not try it out. But of its immediate unwisdom as an act of federal policy in the present exigency of the railroads and at a period of industrial and commercial stress there can be but one dispassionate opinion. In the event it may not even prove to be "good politics."

HOW TO REDUCE DAMAGE CLAIMS.

A certain railroad covering a large territory and handling a great deal of traffic has for several years been trying to classify by causes the claims it has paid out, and it has succeeded in determining causes for about half the amount of claims.

But the magnitude of unclassified losses is so great that it suggests that these losses are largely what is known as "concealed," their proportionate increase in the two years under consideration far exceeding the increase in business done. There is strong reason to believe that thousands of claims of this class are settled because of the difficulty which a carrier has in establishing proof that packages were short or damaged in contents when they were originally packed, perhaps due to the errors of shippers' employees or to more or less accidental causes, even when there is good ground for believing this to be the case. Of course, the effect of this is to make the carrier act as insurer of the contents of packages transported in condition which appears to be perfect, and to put a premium upon carelessness or even upon connivance. After careful study, this railroad has demonstrated clearly that some of these causes are more or less readily subject to cure. With others the conditions can be improved by careful attention, while in a few cases the situation appears to be growing worse rather than better, despite the best efforts of the management. Traffic congestion, which is the most prolific of all causes of loss and damage, has already disappeared, at least for the time being. During the last two years the volume of business transacted has been so enormous that it has inevitably led to carelessness in the effort to keep things moving and prevent accumu-

lation, and this carelessness has affected not only the manner in which the freight is packed, but the way it is marked, shipped and handled on the road. It is believed that the loss and damage account from 1905 until the slackening of business occurred this year, was increased almost 50 per cent. by carelessness alone.

As regards the proper treatment of the determined causes, it has been found that car robberies by employees can be decreased substantially by care in selecting men, by closer general supervision and by specific checks; but robberies due to acts of trespassers and thieves have tended to increase, perhaps owing to the fact that it is very difficult to secure proper action from courts and magistrates on this great evil. The chances are that the local constabulary is more concerned in passing bad characters along and in getting them out of town than it is in locking them up at the expense of the community. No new laws are necessary to stop this short-sighted policy of local expediency, but small towns and cities alike should realize that the act of passing vagrants along turns them up again in due rotation, while the universality of the practice keeps the supply of vagrants always good. The trespassers steal rides, pillage freight cars and help swell the death roll of those hurt on railroad property, and this is true in the United States to a far greater extent than in any other country in the world. Unfortunately, the railroads themselves can do but little to remedy this evil—the burden rests with the communities.

As regards results to be gained by better packing, it should be observed that under prevalent practice it is the contents and not the bulk of a package which pays the freight; consequently a railroad ought to be interested in bringing about strong and compact methods of packing goods—strong, because the carrier is placed almost in the position of an insurer of safe delivery; compact, because of the saving in bulk, and because compactness itself is an element of strength. It is possible for receiving clerks to exercise some discretion about this, but anything like systematic inspection would be resented and might be made the ground of specious complaint. The apparent remedy for bad packing lies in such a modification of the classification and application of tariffs that it will be worth somebody's while to be careful.

Objections to insufficient marking of shipments, especially of packages shipped in less than carloads, are hard to sustain, above all, at competitive points, yet thousands of packages go astray for this reason. A large proportion of the claims on account of errors of employees and of delays are due to defective marking. Each package of l. c. l. freight should be marked plainly for identification and destination. The rule requiring a shipping memorandum from which the marking and the number of packages can be checked ought to be strictly enforced. This particular trouble is one in which the railroads themselves were in considerable part to blame, since they have the remedy in their own hands if they will only act with uniformity.

This remedy is now to be applied. The General Managers' Association of New York appointed a committee to consider the question of losses and damages on behalf of the Association with a view to arriving at a better standard practice among the membership with regard to receiving and transporting freight, and especially to the question of marking plainly l. c. l. packages. The committee presented a report as suggested by the General Managers' Association to the Trunk Line Association, with the result that all the roads east of the Mississippi river operating in the territory covered by the "official classification" have instructed their agents from July 1 to refuse all articles in l. c. l. lots, which are not plainly marked with the name of the consignee, and with the station, city and state, of destination. The railroads will enforce the rule not only in cases of shipments originating on their own lines, but agents at transfer points will also be instructed to refuse to receive from other roads, packages which are not properly marked.

This rule (Rule No. 3 of the classification), though it has long stood in the tariffs, is now to be filed with the Interstate Commerce Commission by each company, thus making it a part of the legal tariff, and therefore a requirement which cannot be ignored without breaking the law. To require one shipper to mark every one of a hundred bags of meal while allowing another to deliver the bags insufficiently marked, would be discrimination, which, of course, is unlawful. An officer of the Pennsylvania says that during the last fiscal year his company paid $342,520 for goods "lost in transit," which is 34 per cent. more than was paid on the same account in the preceding year. The term "lost in transit" refers, we suppose, to those losses which it was found wholly impossible to locate. More than one-half of this sum—or, to be exact, $176,260—represents losses on goods which had been improperly marked or not marked at all. During 1907 the Pennsylvania gathered at one place 18,000 packages on which there were no marks to show the proper destination of the goods, though it is not said that all of these packages remained forever unidentified. This same officer gives a further interesting item in connection with freight losses in the statement that the loss and damage payments by 17 of the principal railroads in 1907 amounted to $5,596,794, which is more than 1 per cent. of the total freight earnings of those companies for that year, and more than one-fifth greater than the claims paid by the same companies in 1906. As it is estimated that 45 per cent. of the payments represent "losses in transit," it appears that losses of this class in 1907 must have amounted to about $2,500,000; and pursuing the estimating process a step further, this officer concludes that one-half of this amount, or $1,250,000, was due to improper marking. Hence, if the 416 roads using the official classification shall strictly adhere to their new resolution, this million and a quarter will be saved. The marking rule is, of course, entirely reasonable, but it is very hard to enforce. If a shipper sends a carload of bar iron or of bags of salt, he is allowed to omit the marks, carload shipments having been excepted from the rule since the year 1; but if he ships 100 bars of iron occupying a tenth of a car, or 1,000 bags of salt, filling only one end of it, the rule at once applies. If the bars are round and only a half inch in diameter, or if the bags are all trade-marked in large red and blue letters, the shipper feels particularly abused. Then he makes sarcastic remarks about the propriety of requiring the destination to be stamped on each kernel of corn in a 30-ton carload, and the freight agent ruminates on the diplomacy required of him by "the Hepburn law."

THE NATURE OF A PUBLIC SERVICE.

"The public does not take into account that a commercial undertaking, worked for the sake of profit, frequently understands better how to satisfy the requirements of its patrons than a less elastic official enterprise. Neither does it appreciate that it is better for the community to be sometimes in conflict, as passengers or consignors of merchandise, with shareholders overanxious for dividends, than to be compelled to pay, in the shape of taxation, for unnecessary facilities provided by a state service under electoral influences."

The phrases quoted above are taken from the introduction to Mr. C. Colson's "Les Traveaux Publics et les Transports." At a period when the nationalization or municipalization of public services, using that expression in its most comprehensive sense, is being discussed from such widely differing standpoints, it is of interest to reproduce the views of a distinguished French writer, who has examined the whole question impartially, and whose opinions must inevitably be colored by the different relations existing in Europe between the government and other public authorities and private enterprise.

Public services can be divided into two kinds, of which the older type includes such functions as home defense, education, roadmaking, etc. These services are usually undertaken by the state or municipality, because while they promise no immediate or direct profit to the individual citizen, their value is, nevertheless, manifest to the community in general. The maintenance of an efficient navy is a case in point. Transportation, none the less a public service, differs essentially from all other national or local services, because, as Mr. Colson aptly puts it, its inherently economic character renders it possible to figure out in hard cash, at least approximately, its value both to the nation and the individual. Therefore, the impossibility of assessing the relative benefit given to the individual citizen by a standing army, for instance, has led the state to divide the expense among the community in the shape of taxation, whereas the value of the service given by a railroad can be exactly fixed and charged. The transportation of a ton of coal 50 miles constitutes a service from which the recipient obtains an immediate pecuniary benefit, the price of which can be determined and paid for by him. Incidentally, this forms one of the strongest arguments against railroad nationalization, since under private ownership the user is taxed in direct proportion to the use made by him, instead of being compelled to contribute toward the expenditure of the state railroads whether he uses them or not.

Now, according to our author, the characteristic feature of a railroad company is that it represents a public service of which the essential object is to benefit private interests. This may appear somewhat paradoxical, but it is to be remembered that in every civilized country an undertaking such as the construction of a railroad

requires specific authorization, and the authorization, whether obtained by private act of the legislature or otherwise, represents in effect a delegation of governmental functions. In France the company obtains a concession permitting it to build and work the line for a given period, at the end of which the undertaking, with all its rights, passes into the hands of the state, which also exercises certain rights of supervision, of rate fixing, and sometimes of participation in the earnings during its existence as a company. The state may also guarantee a dividend, or the difference between a fixed rate of profit and that actually earned. In England and the United States there is no bargain with the state, and the charters are usually granted in perpetuity, with the exception of certain purely local concerns, such as urban railways, which the municipality may have the right to acquire after a fixed period, with or without payment. Similar terminable contracts obtain on the Indian railroads.

Discussing the relative advantages of public and private control, Mr. Colson points out that the construction of a long-distance railroad, between Paris and Marseilles, for example, not only requires governmental authorization, but is an undertaking of such general importance that the state cannot regard the matter with indifference, and must only favor the project if it can be proved to be in the interests of the public. In other words, a service involving certain alterations in the general *status quo*, such as in the ownership of landed property, must be in a position to fulfil its promises of public benefit before those alterations are sanctioned. Competition cannot be anticipated as a certainty, as the individual company possesses an absolute monopoly at least where certain localities are concerned, and can always combine, amalgamate or co-operate with competitors where alternative routes are provided by another concern. The state must, therefore, prevent this monopoly, created by itself, from abusing its powers.

Public services, he continues, are admittedly more spendthrift than private undertakings. This is owing to the fact that in a public administration the actual profits on the working are, if not a negligible, at least a secondary consideration. "Every engineer knows that public works executed by government departments cost more than when undertaken by contractors. In the case of state industries the causes of expense inherent to public administrations produce their full effect." This truism merits reflection, and it has been amply demonstrated by various municipal works departments in England. But the French railroads prove the same. For 1905 (the last year for which complete statistics were available) the ratio of expenditure of the state system amounted to 72 per cent., as against percentages varying from 46 per cent. to 57 per cent. in the case of the large companies. And, although the situation of the state lines is not ideal, from the traffic standpoint, they are, in fact, protected by just those rigid conditions of operations, *e. g.*, as regards the lowering of rates, of which the administration complains. The German system is also costly. On the surface its financial results appear satisfactory. The cost of construction was low, the traffic density is helped by that of the population, and the production of coal is five times that of France. The net profits amount to 5½ to 6 per cent. on the capital expenditure. This result has been obtained not owing to a more skilful administration, but, in spite of a much costlier one. In 1904 and 1905 the ratio of expenditure rose to 63 per cent., as against an average of 52 per cent. for the French lines. Average rates are not lower than in France when the greater proportion of mineral and similar traffic is properly allowed for.

Judicial control over operation, as distinguished from direct government interference, is the system adopted in England. The Railway and Canal Commission may be cited as an example. The Englishman regards the working of railroads, canals and harbors as a branch of industry dependent on private enterprise, and not as a public service worked under contract with the state. France, on the other hand, enjoys an administrative, as opposed to a judicial form of control. This is based on the idea that a company only utilizes the land occupied by the railroad as a delegate of the state or municipality. The privileges and duties accompanying the period of concession, always for a limited time, are clearly defined in the original agreement, and are insusceptible of subsequent legislative modification. In England subsequent legislation can always override the special acts originally obtained by each separate company. One of the weak points of the French system is that the government or other public body, represented by the Minister of Public Works or his agents, can exercise an excessive control that is not always satisfactory to the community at large. He can prescribe the hours of work, the speed, time and number of the trains; in fact, the entire organization of the service. Similar interferences on the part of the state railroad commissions is looming large in this country.

Mr. Colson finally affirms that the delegation of a public service, for a limited period, to commercial concerns controlled by the state is a reasonable transaction. Such inconveniences or evils as may arise are ameliorated by the limitation of the concessions in point of duration, and the power to abridge the period of company working. In spite of the development of communistic ideas, the old system has worked satisfactorily enough, and it may be expected to continue to satisfy the needs of the future, provided that the state endeavor to obtain the greatest use from it, instead of seeking methods of destruction.

London Underground Electric Railways.

THE BAKER STREET & WATERLOO; THE GREAT NORTHERN, PICCADILLY & BROMPTON; AND THE CHARING CROSS, EUSTON & HAMPSTEAD.

The severest competitors are the motor omnibuses and the tramways. These have demonstrated their value for public comfort, but they are operated at a loss, although they occupy the streets—a right of way for which they pay nothing, in comparison with underground railways, which have cost, with their equipment, about £700,000 a mile. The effect and the limitations of this competition are now determinable. For journeys up to two miles long, at the present rates of fare, the motor omnibuses divide the traffic and reduce the underground railway earnings. It requires a nice adjustment of fares, not only to distance, but also to the tastes and requirements of people who live near specific railway stations, in order to get the maximum number of pennies. Sir George Gibb's comment is apt: "The city passenger is an elusive person. If you do not give him what he wants, or if you charge him a little too much, he vanishes in space." The competition of the motor omnibuses compels the maintenance of fares on an unremunerative basis, not alone because the omnibuses are carrying passengers at less than cost and interest, but also because unrestricted competition has lured investment into more omnibuses than are needed. They move in flocks, with too many empty seats, and form an immediate and tempting availability to a passenger to begin his journey at once without counting the time and cost of that journey. It is a condition of things that cannot last, but it is costly while it lasts to omnibus and railway owners alike. It would seem to be inevitable that the stop-loss period would soon come and that the omnibus owners must virtually increase fares by a shortening of the penny zones. This would raise the average fare for omnibus travel, without seriously diminishing the numbers traveling, and such traffic as the omnibuses might lose would probably be more than compensated for by the additional receipts from the traffic carried. In fact, the problem is to put the business on a paying basis. It is not good business permanently and deliberately to fix the price of the product of an industry at a figure which on the average cannot yield any return on capital invested.

The advantages, disadvantages and difficulties of the deep-level tube, reached by lifts, compared with those of the shallow subway reached by a short flight of steps from the street surface, have been fully and perhaps finally presented in a remarkable discussion at the Institution of Civil Engineers. Nothing needs to be added to the facts developed by Barclay Parsons' opening paper and other speeches by distinguished engineers and railway managers. In number of evenings and number of contributions to this discussion, the institution's record for 40 years is exceeded.

Some questions are settled. The shallow subway is the more effective competitor with surface means of transportation because of the saving of some minutes of the passenger's time on each journey, being time spent in the lifts and passages. The cost of operating lifts is an added cost. For these commercial reasons the shallow subway, where it can be built at reasonable cost, is the better money-earner. But it was made clear that in the narrower streets and congested districts in London the subway is not feasible, primarily because of the number of underground pipes to be dealt with in limited spaces. The obvious advantage of the deep level tube railway is greater comfort for passengers, due to less noise and smoother riding. There is the further important consideration that, so far as one can see in the future, the tube construction is decidedly more enduring than the subway. In the course of years the cost of upkeep, and possible costs of some subway reconstruction, are not to be ignored.

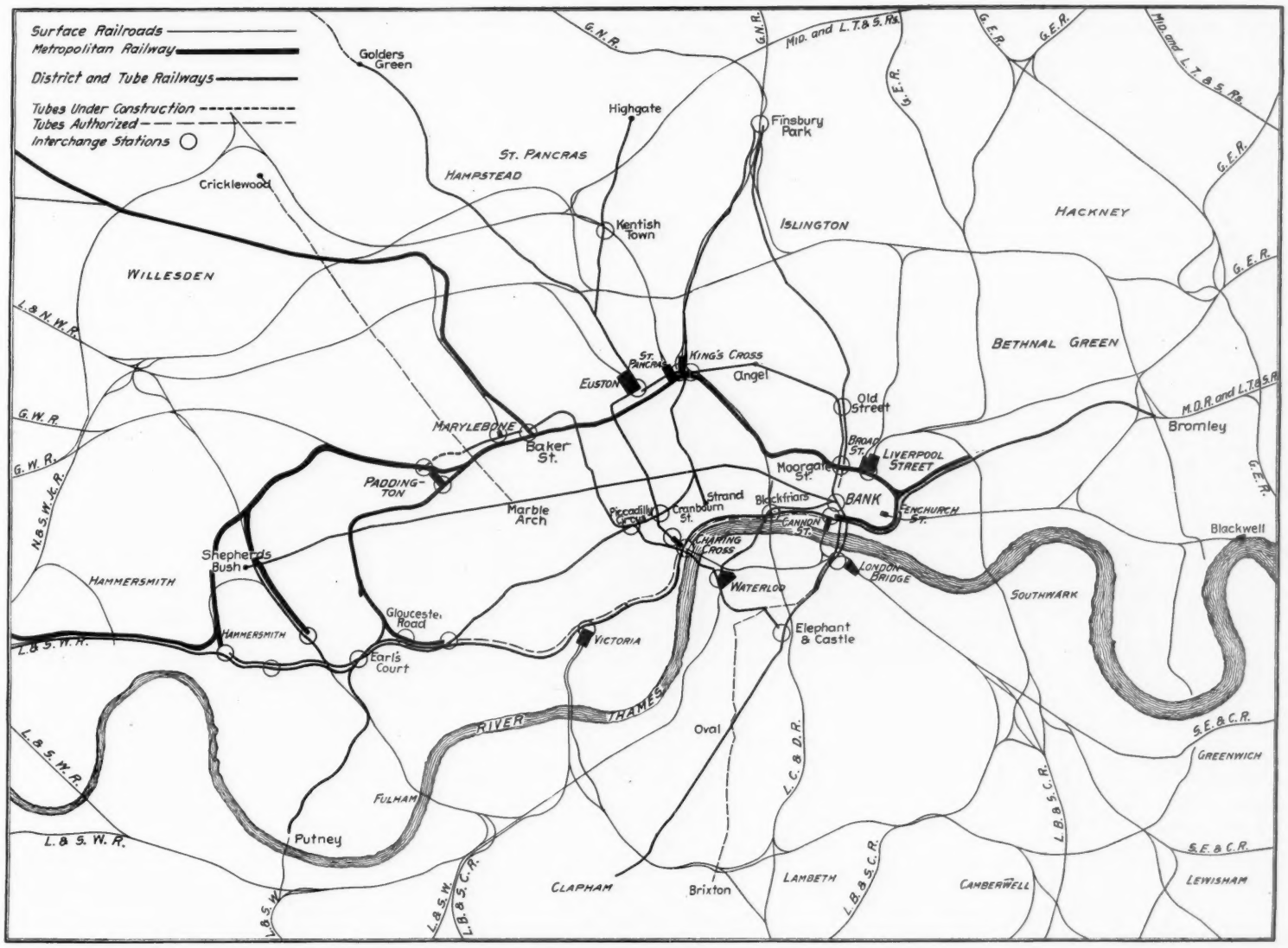
Though there are still some projects for underground railway construction in London in more or less distant view, it may be said that there is now such a fairly completed system that we may with advantage take stock of some of the results achieved, and of the lessons to be learnt from the experience thus gained. In doing so it is impossible to avoid comparisons, but with these, as indeed with all engineering works, progress is inevitable, and the later constructions necessarily obtain the advantage of the experience of the earlier ones. In drawing attention to that earlier experience,

comparisons must not be regarded as invidious, for the inventive genius and practical capacity of the designers of the first works of the kind are by no means to be considered inferior to those of the later ones to which necessarily we turn for our instruction. In no profession perhaps more than in that of the railwayman, do we learn by the results of trial.

THE PERMANENT WAY.

It would probably occur to any permanent way engineer, on examining the drawings of the permanent way adopted as the standard for the three latest underground tubes (the Baker Street & Waterloo; the Great Northern, Piccadilly & Brompton; and the Charing Cross, Euston & Hampstead) that a basic principle is violated with the probable result of either breaking the sleepers or of producing unpleasant and possibly dangerous side oscillations. The result has proved, however, that here is another example of the broad fact that the engineer must not allow himself to be bigoted; that principles are based on conditions and that the conditions with the track firmly enclosed in a tube, are, in at least one respect, distinctly different to those which prevail in the open, being defective. The gangers are taught to tamp heavily directly under the rails and leave the center of the sleepers with only light filling. The reverse of this would produce what is called a "center-bound" track, likely to produce side oscillation in the vehicles and to break sleepers. In tube construction, however, there is this difference: The mass of crushed granite cubes directly underneath the sleepers, where the chairs rest, is confined laterally in the tube. The wheel pressures on the rail tend in a degree to drive this granite toward the sides of the tubes, but gravity acts in the reverse direction, tending to continually tamp the granite underneath the sleeper. The result is what might be expected: A track firmly supported but with a slight elasticity, or rather resiliency, that is useful in modifying shocks and reducing noise.

The amount of this elasticity can be accurately measured. Sawed Australian jarrah wood is used for the sleepers. Each sleeper has two fulcrums immediately beneath the inside of the inner lines of the chairs, so that the rolling loads on the rails have a leverage of a few inches, and each sleeper with its fixed center acts as a spring. The extent of this spring action in the sleeper can be ac-



London Tubes and Subways.

where the wheel pressure is transmitted through the sleepers to the ballast and can drive the ballast support downward and laterally from underneath the sleepers. The undertaking in designing this novel form of track was to prevent the jar, tremor and noise which had resulted in other deep tube construction in London, and which had proved to be not only an annoyance to passengers, but costly in damages and law suits with owners of nearby property. It was plain that if this could be avoided at any reasonable cost, the result would be a more attractive transportation machine accompanied with less cost.

The novelty consists in bedding the sleepers and fastening them to a cement grout center bearing, which clasps the sleepers firmly for a distance of 3 ft. 10 in., and furnishes a somewhat resilient support for the sleepers directly under the rail chairs. The support directly under the rail consists of clean crushed granite broken so as to pass through a ¼-in. ring. In all other permanent way construction the undertaking is to form as firm and rigid a support as possible directly underneath the rails and leave the center of the sleepers only lightly tamped. Any other method of supporting the sleepers in ordinary railway practice is rightly considered as curately indicated by attaching a pencil to the end of the sleeper in such a way as to mark on a nearby vertical board and accurately record the rise and fall as the trains pass over. Repeated records of this kind show that there is a vertical movement of about a quarter of an inch at the end of the sleeper, indicating that there is a springlike action under the wheels with a limit of movement of less than an eighth of an inch. It would be difficult for the engineer to say what amount of cushioning is ideal in taking up the shocks under the rolling loads, but in this case the results seem to be ideal. The passenger is able to observe but little jar and the wheel-on-rail sounds are slight. Careful examination with a seismograph on the street surface over the line of these underground tubes finds no evidence of tremor, and yet the seismograph was so delicately adjusted that the shocks due to a passing vehicle on the street at a considerable distance away, were easily recorded.

These records were made by A. Mallocks, of Greenwich Observatory, in March, 1906, and covered a wide range of observations in dwelling houses, street surfaces over the tubes, and station platforms in the tubes. These observations are recorded in an official report of great length. The results in general are that in dwellings

over the line the vibrations produced by a person walking on the floor were something like 100 times as great as those produced by passing trains. The vibrations caused by a brewer's dray on the pavement directly over the tubes were more than five times that produced by the train underneath. Aside from the avoidance of law suits and costs, the result is nearly an ideal track, immovable, enduring, easy and economical for the rolling stock, comfortable for the passenger, and with a low cost of maintenance. It seems to be a novel undertaking; in some respects it was a bold one.

STATION ENTRANCES AND EXITS.

There is no doubt that in some of the London tubes the length of the passages between platforms and lifts and between lifts and street exits and entrances makes a serious addition to the time of the journey. It furnishes an effective argument to those who, like Sir John Wolfe Barry, are strong advocates of the shallow subway in preference to the deep tube. To avoid long passages it is obviously necessary to fix the station offices as nearly as possible vertically above the platform. The opposite condition arises from the principle, so cherished in England, that the convenience of the million must give way to the rather exaggerated rights of the hundreds. To escape the costly demands of owners of property who possess not only special plots on the surface of the earth, but the pyramidical continuation of them to their apices at the center of our planet, the tube must be kept, as nearly as practicable curves will allow, under the streets, and as our mediæval ancestors who constructed them never contemplated tubes, there are curves, and sometimes sharp ones, to follow. As curved platforms are inconsistent with long cars, leaving ugly chasms for people entering or leaving them to fall through, and as they furnish obvious difficulties in the way of hand-starting signals, platforms must be kept to the straight or nearly straight portions. So much for the position of the subterranean work. As to the site of street entrances and exits, other conditions are influential. Any liquor legislation which would reduce the number of public houses would help in the convenience of approach to the tube platforms of the future. These establishments stand on most of the principal corners, a position eminently favorable for, and in the railwaymans' view, naturally much more suitably occupied by, railroad stations. The expensive acquisition of the proprietor's rights, and of these and other sites, greatly limit the choice of the engineer in fixing the position of street entrances and offices, and so these and the platforms have often to be widely separated horizontally. "Proputty, proputty," as Tennyson calls it, stands ever in the way of convenience in the route of nearly every railroad in older lands, but especially so in the particular case of tube station approaches. These difficulties have not been so much felt in the Central London line, owing to the nearly straight course of the overlying streets, which it followed without much difficulty. Nevertheless, the engineer appears to be open to criticism in not having more often succeeded in getting station entrances nearly over the platform centers and so avoiding long passages. The station entrance does not need to be at a street corner. It may be in a more obscure location, with a great saving of time for passengers.

LIFTS.

The lifts of the Piccadilly, the Bakerloo and the Hampstead Tubes are of all steel construction, except the floor, which is of the not easily inflammable jarrah wood, and have a maximum capacity of 1,000 passengers per hour in one direction. Unlike the general design which has been adopted in the earlier types, the exit of the cages at both ends of their range is at the opposite side to that of the entry, one controller in each cage controlling both doors. Of course this requires a different plan of approach passages. These lifts may certainly be considered absolutely fireproof.

THE AUTOMATIC SIGNALING SYSTEM.

The wonderful, the better-than-human, automatic, electro-pneumatic block signaling installation, and the pneumatic power interlocked movement of points and signals needs a long description in order to understand its details, but this has already been done. We are here concerned only with its purposes and results. These are: Safety in the prevention of rear-end collisions. Capacity for the greatest possible number of trains per hour. Economy in cost of operation.

The blocks on the tubes and busy parts of the Metropolitan District are only about 900 ft long. If the controlled manual system, such as is working on the Central London, were used it would require a cabin and a man for each of these short sections, and with their utmost skill not more than 30 trains an hour could be moved. In the new tubes and on the District the signals automatically set by the moving train, without man power, easily permit a safe movement of 40 trains an hour. This allows a large increase of earning power during the busy hours, and it is accompanied by a large saving in operating cost. Near each signal is an automatic train stop, a track instrument which lifts when the signal is at danger and, if the leading motor passes over it, catches a brake-valve handle and sets the brakes throughout the train. This stops a Tube or District train, running at schedule speed, in a distance of little more than 200 ft.

At each interlocking station, the signalman has before him an automatically illuminated diagram which shows him the progressive movement of trains approaching him. He is also informed by an annunciator in his cabin of the route to which he should shunt a specific train. This is accomplished by an electric combination called the "Magazine Train Describer."

Still another refinement, and this entirely for the convenience of the public, is the "Train Destination Indicator," which is placed in plain view from the platforms of many stations on the District Railway. It tells waiting passengers the route and destination of the next three trains to the many branches of the line.

The economic results of this wonderful signaling installation are many. Like the steam shovel, whose reason for existence is that it gets men off the bank and out of the way, it does this and more, for it reduces the coefficient of human error. It saves something like one-third of the cost of signaling by human power. It increases the capacity of the line by one-third.

VENTILATION.

The advance has been great. In the City & South London, which was the first of the tubes, in the Waterloo & City, and at first in the Central London, the subject was not ignored, but it was thought that the movement of the trains, filling as they do a large percentage of the area of the tube, would draw or push the air sufficiently rapidly, that with the help of the communication between the two tubes at stations, the outlets at the latter would become alternately exhaust and supply ducts for foul and fresh air respectively. This is commonly called "the piston action" of trains in tubes. Experiments in the Central London on the velocity and direction of the air at the mouth of a running tunnel showed that the air flowed first in a direction opposite to that of a moving train; that the velocity gradually decreased to zero just when the rear end of the train had entered the tunnel, and that the direction then was reversed. The City & South London line still trusts to this action and the air is chemically well within the limits of allowable CO_2, that is to say 13 parts in 10,000, but it must be said, taking into consideration other pollutions, there is much left to be desired in the enjoyment of the atmosphere. This defect is not so pronounced in the Waterloo & City owing, no doubt, to the shortness of the line and the fewer number of trains within the tunnel at the same time. The tunnel under the Mersey at Liverpool was ventilated by shafts midway between stations for the purpose of exhaust and intake, but taking into consideration the cost of property in London, any such arrangements would obviously be objectionable. In the Great Northern & City line, however, a space for the purpose was obtained comparatively cheaply between Essex and Old Street Stations. This arrangement was not possible on the Central London, where it was soon found, owing to its length and the enormous and continual traffic, that the train movement was insufficient, and that some other device would be necessary. The plan adopted was to install a mine fan of the Guibal type at Shepherd's Bush, by which the air from the whole six miles of the double tube to the Bank Station is supposed to be drawn out, but this is limited to the few hours at night when the traffic ceases. This proved a great improvement, but as every traveler on the line knows, the peculiar earthy smell has not been eradicated and is specially noticeable at the evening approaches, when the effects of the fan are beginning to be worked off. Whatever the chemical constituents of the atmosphere are under these conditions, they appear to have a soporific effect on the human system. The average travel on this line is probably not more than about 15 or 16 minutes, so that it is not likely that the health of the passengers is in the least degree affected, but in the face of severe competition with above-ground traffic, where, comparatively speaking, pure air can be breathed, the matter becomes of some importance to the public, and still more to the men working the trains.

Guided by these experiences, those who were responsible for the later tubes, the Great Northern, Piccadilly & Brompton, the Baker Street & Waterloo, and the Charing Cross, Euston & Hampstead, have adopted a system which is thoroughly effective. Fans are fixed at the roof of every station, except in parks, and exhaust the air by ducts of from 12 to 16 sq. ft. area. The intakes are the ordinary passage ways and lift wells. As the areas of these passages are much greater than the exhaust ducts, the velocity of the air in these passage ways is not found to be excessive. The fans are designed to draw off 1,000,000 cu. ft. per hour, which is sufficient to cause renewal of all the air in the average length between station and station in both tunnels every 30 minutes. In a test made at Waterloo the expenditure of power per million cubic feet exhausted was 8.1 horse-power hours, the revolutions being 240 per minute, and the quantity of air passed in the same time 1,125,000 cu. ft. The working of the fans is nearly noiseless. The results are ideal.

FIREPROOF CARS.

Electric traction escapes some of the dangers of the steam locomotive, but involves new and serious dangers to be guarded against. Fire can be caused by short circuiting of the conductors within the cars, provided there is anything in the car that will burn.

The Paris Metropolitan burning will be remembered as well as that on the Liverpool Overhead Railway when a large number of creosoted sleepers were burnt. In the Paris case, much of the material of the cars was pitch pine, untreated, which ignited readily under the fierce heat generated by the electric current, and by this catastrophe, more than any other, we have been warned of the needed precautions.

Underground travel is such that panic is easily excited at any apprehension of accident, a panic that is often in itself more dangerous than an accident. In the later London underground electrifications, practically all this danger is eliminated. The wood in the District Railway cars is treated with chemicals which render it almost incombustible. It becomes charred only under continuously applied intense heat. It does not flame, and does not by itself continue to burn. The cars of the three recent tubes—the Piccadilly, Bakerloo and Hampstead—are nearly all steel. That safety has been attained, even where all steel cars are not in use, is illustrated by the slight misadventure, for we can hardly call it more, which took place at Sloane Square, on the District line, on January 8 last. It was caused by defective insulation of the electric lighting wires. The resulting heat melted a small plug of bitumen, followed by an explosion caused by the ignition of the bituminous vapor, and making smoke and fumes. Electric flashing followed along the pipe carrying the lighting wires to the junction-box under the cars, and the fireproofed timber flooring was slightly charred. All of this, though quite sufficient to create alarm, was not in the slightest degree dangerous, and it is probably due to the small number of people at the time in the car, and their self-possession, that a panic did not occur. Even the harmless explosion can be avoided by the use of an insulating material which would not emit inflammable vapor.

Though unnecessary to prevent spread of fire in the cars, which, as we have said, can be easily mastered, a provision against the consequences of collision has been adopted on the District cars which is worth notice. This is a heavy $\frac{5}{16}$ in. steel partial bulkhead at each side of the end entrance doors, transverse to the cars and stiffened with vertical angles. Though there have been many minor collisions on various occasions, not one of these has failed to protect the main portion of the car between them, and if unfortunately such an occurrence of a more important kind should take place, there is good reason to suppose that these strong plates would partly diminish bad results.

The Piccadilly and the Hampstead Tube cars are noisier than those on the Baker Street & Waterloo, although all of them run on the same nearly noiseless track. The most pronounced sounds come from the wheel pockets in the car bodies, just over the trucks, although there is an additional roaring which seems to come from the side walls. The side wall, under the window line, of the Baker street cars, consists of a continuous sheet of heavy boiler plate, thick enough to be dignified by an engineering definition as a web girder, a rigid support forming a nonvibrating structure. The walls of the other tube cars consist of a riveted truss, covered by a very thin sheet of metal. The result is what might be expected. But these tube trailer cars weigh 16 tons 13 cwt., while the Baker street trailers weigh one ton more. In electric traction the costs increase strictly in proportion to the tons hauled, so that at the present time the traction costs of an empty Baker street trailer car are 6 per cent. more than for the other tube cars. Additional comforts are apt to cost something.

AXLE BREAKAGES.

Some time ago the failure of axles on the Metropolitan District line, when the new cars were introduced on its electrification, caused some attention. There were really very few cases, but the breakage of an axle is a serious matter, and might cause derailments resulting in loss of life. It is therefore satisfactory to know that these failures arose from an easily ascertained and remediable cause, viz., the tightness of the gage of the rails at the crossings, which were found to be specially noticeable at the Mansion House station, amounting to as much, in some cases, as ¾ in. Since this defect, which put such a strain on the axle, has been corrected, the breakages have ceased.

COTTON BRAKE BLOCKS.

The use of metal brake blocks has long been a source of trouble on electrical lines. The pulverized steel resulting from the action of the brakes and ground from the blocks and the wheels accumulate in the road, and it is necessary to brush and clean the insulated rail joints carefully and frequently to preserve the track circuits. In the New York subway, the amount of metal lost from the brake-shoes is roughly about one ton per mile per month. This has been ascertained by the weight of brake-shoe metal required for renewals minus that which is scrapped. It may be inferred that the wear from the wheels is about the same. The quantity of pulverized steel collected in the Paris Metropolitan is scarcely less, and on the Boston subway these rapid accumulations are troublesome. To obviate this, brake blocks of cotton fiber have been adopted on the new London tubes, where they have been completely successful, though when used in the open parts of the District line. defects have been observed which are now being investigated. The blocks consist of five layers of heavy woven cotton impregnated with resin and asphalt. Its coefficient of friction is considerably higher than that of cast steel blocks, and in use it is necessary to train the motormen to make a somewhat lighter application than with the metallic blocks in order to avoid sticking and skidding, but when the train line pressure is reduced to 10 lbs. satisfactory results are obtained.

Trouble was at first experienced by the flowing of the sheets outwardly away from the wheel flanges so that, occasionally, parts fell on the permanent way and, owing to the impregnation, clung to the rail where they usually dropped, giving rise to false reports of broken rails. Cotton fiber has no grinding effect on the wheel tire, but it has the slightly bad effect that it does not keep the wheels trued, and inexperienced motormen are liable to produce a series of small flat spots due to short-time skidding. The blocks having no cutting action, the tires remain somewhat rough to an extent that can be detected in rough riding. This is a small defect inasmuch as it can be easily obviated by training the men. On the other hand the absence of grinding action has a highly beneficial result in the saving of tire wear, and the consequences of it to which we have already referred. The average life of the cotton composition brake block in the tubes is found to be on trailers about 20,000 miles, as against 13,000 miles with metallic blocks. The cotton fiber blocks have not so far been successful on the open parts of the Metropolitan District line, as shown by experiments made on their South Harrow branch, probably owing to damp. These become "clammy," in the language of the men in charge, and there appears to be difficulty in releasing the brake, showing a want of uniform adhesion and some erratic actions. The brake blocks have the appearance of having absorbed some moisture, although it should be possible to overcome this fault.

In these days of rapid retardation, on which the speed of short stop travel so much depends, it is worth the consideration of those who design city lines whether the switchback construction of station approach grades, which diminish so much the work of braking, has been developed as fully as might be possible. Of course, where the speed and weight are fairly uniform, it might be possible to plot a vertical grade curve, the effects of which, coupled with the ordinary train resistance, might, apart from the effects of wind, stop the train almost to a yard. In lines through city and suburbs where the level is near the surface, grades must be more or less subsidiary to existing levels of roads, streets and to other considerations, but with almost incessant heavy trains, the diminution of brake action in stopping, not to speak of assisted acceleration in starting, will, no doubt, be worth some extra expenditure in construction to attain it.

The engineering staff in charge of construction of the Baker Street, Hampstead and Piccadilly Tubes was organized as follows: Chief Engineer, James R. Chapman; Engineer of Tube Construction, H. H. D. Hay; Architect, Leslie W. Green; Substation Construction, J. W. Thomson; Construction Engineer, W. E. Hanson; Resident Engineer Power House, J. W. Towle; Electrical Engineer, S. B. Fortenbaugh; Lift and Ventilating Engineer, G. Rosenbusch; Signal Engineer, C. E. Strange; Purchasing Agent, H. B. Twyford; Rolling Stock Superintendent, E. S. Albanese.

In addition to the above there were Parliamentary engineers for the tube lines as follows: Baker Street & Waterloo Railway, Sir Benjamin Baker, Messrs. Galbraith & Church; Charing Cross, Euston & Hampstead, Sir Douglas Fox and partners; Great Northern, Piccadilly & Brompton, Finsbury Park to King's Cross, Alexander Ross; King's Cross to Covent Garden, Sir J. Szlumper & Son; Covent Garden to Hammersmith, Sir J. Wolfe Barry and partners.

The Legal Height of Freight Car Couplers.

We published last week the decision of the United States Supreme Court on a case which arose in Arkansas, in which it was held that railroads must strictly comply with the law that fixes a standard height for the drawbars of freight cars, the court holding that evidence of reasonable care on the part of the railroad company would be no excuse for failure. The information given was correct, as far as it went, but it was based on a press report, which proves to have been incomplete. The full decision has since come to hand, and, in view of the differences of opinion which have existed as to the precise meaning of the drawbar rule, as it was formulated by the American Railway Association, and approved by the Interstate Commerce Commission, we quote from the decision the full interpretation of this law as laid down by Mr. Justice Moody. Justice Moody says:

> We think that this act requires that the center of the drawbars of freight cars used on standard gage railroads shall be, when the cars are empty, 34½ ins. above the level of the tops of the rails; that it permits, when a car is partly or fully loaded, a variation in the height downward, in no case to exceed 3 ins.; that it does not require that the variation shall be in proportion to the load, nor that a fully loaded car shall exhaust the full three inches of the maximum permissible variation and bring its drawbars down to the height of 31½ ins. above the rails. If a car, when unloaded, has its drawbars 34½ ins. above the rails, and in any stage of loading, does not lower its drawbars more than three inches, it complies with the requirements of the

law. If, when unloaded, its drawbars are of greater or less height than the standard prescribed by the law, or if, when wholly or partially loaded, its drawbars are lowered more than the maximum variation permitted, the car does not comply with the requirements of the law.

It should be said that the supreme court decided the case in favor of the railroad company, reversing the opinion of the supreme court of the state of Arkansas. The two cars between which Taylor was killed had different types of drawbars; one a vertical plane, and the other a link and pin. So far as can be judged from the statement of facts, the case was litigated wholly on the technicality of the height of these drawbars, and the fatal injury to the man was not due to the difference in height. One of the cars was fully loaded and the other partly loaded, and the trial judge, who was sustained by the state supreme court, had charged that these cars were run in violation of the federal law, because the drawbar of the fully loaded car was more than 31½ in. high. The Supreme Court of the United States, in accordance with the rule quoted, held that the couplers did comply with the law.

The Cape Cod Canal Project.*

BY WM. BARCLAY PARSONS.

In the consideration of an inside water route along the Atlantic seaboard of the United States, the link that will connect the waters of Long Island sound and Massachusetts bay is, in respect of size and character of vessels and the extent of tonnage that will use it, the most important, and historically the most interesting of all the sections that, when completed, will make possible a voyage from Maine to the Gulf of Mexico free from interference by stress of weather or attack by enemy in case of war.

A glance at the map of Massachusetts shows projecting from its southeastern corner a great arm, running first easterly thirty-five miles and then northerly about the same distance, terminating in a hook at Provincetown. To this arm the name of Cape Cod is applied. This curious geographical formation is everywhere flat, with few hills, especially to the east, and is composed chiefly of sand and gravel. Around this cape all sea-going traffic between Massachusetts bay ports, such as Boston and Portland, and all ports lying to the south must pass.

The circumnavigation of the cape is far from easy. On the south side lie Martha's Vineyard and Nantucket islands, inclosing Vineyard and Nantucket sounds, with their high tidal currents and many shoals; while to the east are the great shoals extending southeasterly to the celebrated Nantucket shoals, marked by the light vessel of that name. These shoals, the low, sandy coast, difficult to see in thick weather, the frequent fogs, and the unbroken exposure to northeast storms, have made the passage of the cape a dreaded one to all mariners, and the record of wrecks year by year, with their shocking loss of ships, cargoes and life, is ample testimony that their fears do not lack foundation.

The only place on the cape where its breadth is material is the southerly projection toward Falmouth, which, with the extended chain of islands, forms the eastern shore of Buzzards bay. At the head of the bay the distance overland to Barnstable bay is less than eight miles. This distance is made up in chief part by the Monument river to the south and the Scusset river to the north. Separating them is a ridge whose height is only 30 ft. above sea level. The deepening of the rivers and the cutting of a canal through this ridge, making thereby a direct water route, avoiding the journey around the cape, is so obvious a shortening of distance and reduction of marine risks as to cause wonder it was not long since done. The contemplation of such a channel is, in fact, almost coeval with the Pilgrim settlement at Plymouth in 1620. The records of that colony show that in 1622 a party succeeded in getting a boat around the cape, only to have it lost in Vineyard sound. The year following they discovered that from Manomet, an Indian town within twenty miles of Plymouth, there flowed a river southerly to a bay which opened towards Narragansett, and within a short time afterwards the thrifty colonists established there a trading station, between which and the Dutch settlement at Fort Amsterdam there at once developed a brisk trade, the Dutch vessels ascending the river to Manomet, whence the goods were carried the short remaining distance overland to Massachusetts bay. Before the seventeenth century was one-third gone there was thus established the beginning of the Boston-New York water-borne trade, which has since grown to such huge proportions. The old name of Manomet has unfortunately been corrupted into the meaningless form of Monument, and as such is now applied to the river which the Plymouth colonists found.

In 1791, Massachusetts having now become a state, the legislature appointed a committee to inquire into the possibility of a canal across the cape. From that time until 1824 the question was continually before the state legislature. In the latter year the government of the United States intervened, and by a joint resolution of both houses the President of the United States was authorized to cause the necessary surveys, plans and estimates to be made for a canal across the cape. As a result of this survey, detailed plans were finished for a canal which was to be 36 ft. wide on the bottom, 60 ft. wide at the surface of the water, with a depth of eight feet, the canal to be equipped with locks.

The eminent French engineer, Major William Tell Poussin, who visited this country in 1831, and who, on return to France, made an extensive report on public improvements of the United States, describes, with elaborate drawings, the Cape Cod Canal as being one of the greatest pieces of construction contemplated on the American continent. From 1830 to 1860 the project languished, but in the latter year the legislature of the state of Massachusetts once more took it up, reported, and again reported in 1864. From that date until the present the question of the canal has been at intervals under discussion. The state granted a charter under which work was actually begun; funds, however, were not forthcoming in sufficient amount, the work was abandoned and the charter allowed to lapse. In 1899 the legislature passed another charter, amended in 1900, in accordance with which plans for a canal have been prepared by the writer, submitted to the joint board of railroad and harbor and land commissioners of the state of Massachusetts, approved by them and work begun.

All the early schemes for a canal at this point contemplated locks. Brevet Major-General J. G. Foster, Lieutenant-Colonel of Engineers, U. S. Army, in 1870, was the first to call attention to the fact that, although there is a considerable difference in tidal phenomena at the two ends of the canal, nevertheless the resulting current will not be sufficient to require locks. This same view has been sustained by many eminent authorities, among them the late Colonel A. L. Rives, for many years superintendent and chief engineer of the Panama Railroad; Dr. Elmer L. Corthell, the associate with Captain Eads in the Mississippi jetties, and himself the constructor of many notable harbor developments in various parts of the world, and Mr. Clemens Herschel. The plans that are under construction therefore contemplate a canal free from locks or dams. The law requires that the bottom width shall be not less than 100 ft., with passing places where the bottom width shall be twice as great, and with a minimum depth at any point at mean low water of 25 ft. In actual construction it is probable that the minimum width will be greatly exceeded; in fact, it is most likely that the passing places, instead of being made three in number, will be connected so that the canal will have everywhere a bottom width of 150 to 200 ft., and a width at the surface of from 250 to 500 ft., depending upon the slope that the banks will take. These dimensions can be compared with a bottom width in the Suez canal of 147 ft., in the Kaiser Wilhelm canal at Kiel of 72 ft., and in the Manchester canal of 120 to 200 ft.; the depths of these canals vary from 26 to 30 ft.

From the shores of Barnstable bay to shores of Buzzards bay is a distance of eight miles. The sharpest curve is projected to have a radius of 7,640 ft., so that navigation for vessels of any size within the limits of depth will be simple. At the south end Buzzard's bay is land-locked and affords an excellent harbor; at the north end the canal will flow directly into the open waters of Barnstable bay without any natural protection. This bay is open to storms from the north and northwest. It is proposed to provide protection against winds coming from this direction, to build a breakwater for a distance of 3,000 ft., running easterly and extending to the six-fathom curve at low water, so that vessels entering from the open bay, even in rough weather, will be able to obtain smooth conditions before entering the canal. In addition, the United States government should construct a harbor of refuge by the building of other breakwaters, so that vessels, after having passed the canal, may lie at anchor in the waters of Barnstable bay until such times as they are ready to continue their voyages, if delayed by stress of weather, accident or other cause. Such harbor is so obviously a part of open sea navigation that it logically should be done by the government as similar works are done along the coast, and not by a private company.

This canal is not a channel for local traffic, but is essentially a ship canal for ocean-going vessels in through service. The figures of proposed depth and width of the Cape Cod canal show that it will be of the same general character as to size as the great ship canals of the world, and the dimensions are amply sufficient to accommodate all vessels engaged in the coastwise traffic at any stage of tide, and permit them to pass each other in opposite directions without hindrance. In fact, the canal will be of really greater capacity than the above figures would indicate, which are based on mean low water conditions. Since the tide rises in Buzzards bay about five feet, the depth of water in the canal when there is high tide in Buzzards bay will be 30 ft., a depth that will be substantially maintained at that time through the canal, as mean tide at Sandwich, which occurs when there is high tide in Buzzards bay, will also give 30 ft. depth at the north end. Available draft can therefore he said to vary from 25 ft. as the minimum to 30 ft. as the ordinary maximum. The latter depth would suffice to carry vessels of the battleship class, should the government ever have occasion to send such vessels through the canal.

*From a paper read before the Atlantic Deeper Waterways Conference, Philadelphia, November, 1907, and reprinted in the *Annals of the American Academy of Political and Social Science*, January, 1908.

The general trend of the Atlantic coast is northeasterly. A straight line drawn from the mouth of the Chesapeake, or the mouth of the Delaware, or from Sandy Hook, to Boston, will cut the land well to the westward of the proposed canal. The actual saving in distance will therefore be the same for any vessel trading between a Massachusetts bay port and practically any of the ports on the Atlantic seaboard. Vessels now making this journey have two courses open. In going from New York they can pass through Long Island sound and Vineyard sound around the cape; or they can go by sea past Sandy Hook, and then from Montauk Point either through Vineyard sound, as before, or to the southward of Martha's Vineyard and Nantucket islands around the cape. Vessels from Philadelphia, Baltimore, Newport News, Norfolk, Wilmington, Charleston, Savannah, Brunswick, or any other port, can pass Montauk Point and go either through Vineyard sound, as above, or to the southerly of the two islands.

Taking a common point of departure by the inside route through Vineyard sound, there would be a saving in going through the canal of 66 miles in distance; or, by taking another common point of departure outside of Montauk Point, there would be a saving of 63 to 71 miles for vessels going through the canal instead of passing to the south of the islands, according as bad shoals are crossed or avoided. Or, if in the latter case, a vessel should wish to escape all the Nantucket shoals and make a complete circuit rather than go across, there would be a saving of 129 miles between New York and Boston, and 105 between Philadelphia and Boston. For points south of Philadelphia, the saving in distance would be substantially the same, although, as compared with the journey length, necessarily proportionately less. The saving in distance is not, however, the only saving that would be realized, as the worst part of the journey is the journey around the cape, whether it lies across the shoals or goes around them.

Fogs, storms and adverse currents frequently keep vessels storm-bound either at Provincetown or in Vineyard sound for days at a time, so that no certain time of arrival can be predicated even for vessels in tow, still less for vessels under sail, while the terrible list of wrecks on the shores of the cape attest the foolhardiness of attempting to make the journey in bad weather. During the year 1905, the last for which statistics are available, 14 vessels were lost on the shoals and the short stretch of 35 miles of Cape Cod coast. The tonnage of these wrecks composed 24.1 per cent., or say one-quarter, of the total tonnage of wrecks reported on the whole coast line of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut and Long Island. So measurable is the danger of Cape Cod transit, as compared with the quiet navigation of Buzzards bay and the canal, that inquiries addressed to the marine underwriters in New York elicited the response that insurance rates on the cargoes of sailing vessels and barges would be reduced from 10 to 25 per cent. to vessels using the canal.

The traffic that would seek the canal route is of three classes:

First—Passenger steamers between New York and Boston. This business is now handled in two ways: by vessels running to Fall River, Providence, New Bedford, or other sound ports, and thence by rail to Boston, or by vessels going around the cape. The first method requires but one night for the journey, but it involves a transshipment of passengers and freight inconvenient to the former and expensive for the latter. The second method requires usually 18 to 20 hours, or say a night and the forenoon of the following day, unless further delayed by thick weather. The canal will permit the journey to be completed in 13 to 14 hours, or comfortably between evening and early morning. To show the extent of this traffic, there are running regularly every night between New England ports, exclusive of any north of Boston, 24 large steamers both ways, of which 16 carry passengers. During the summer not only is the total increased, but also the percentage carrying passengers. Of the 24, the New England Steamship Company controls 16. All these steamers pass out through Long Island sound, and by far the greater portion of the passengers and freight would be more expeditiously, economically and comfortably handled through the canal.

Second.—Steamers carrying chiefly freight, but also some passengers, between Boston and ports south of New York. Lines are regularly established from Boston to Philadelphia, Baltimore, Norfolk, Charleston, Savannah and Jacksonville, with 20 sailings weekly both ways, offering an annual freight capacity of more than 2,000,000 tons. In addition there is a large volume of freight traffic, chiefly fruit, from the West Indies and Central America, steamers from such ports entering at Boston custom house to the extent of over 200 annually. All this traffic could save by the canal, and much of it will use it.

Third.—Freight traffic of raw materials transported in sailing vessels or barges. This traffic would furnish the major volume of the canal business, and it consists chiefly in coal, southern lumber for New England, Maine lumber, such as spruce for points south of the cape, stone from Massachusetts and Maine, ice south-bound, cement, brick and lime north-bound, oil and oil products, cotton reshipped at New York, and other bulky commodities. Such articles must be transported cheaply. The New England railroads leading from New York are now so congested with passenger traffic and the carrying of high classified freights that such articles as those stated above cannot be given the low rates that their value demands—such traffic must go by sea.

In point of tonnage, the biggest item in the above list is coal. During the year ended June 30, 1907, it is estimated that the coal shipments to Massachusetts bay ports, of which Boston and Portland are the chief, amounted to no less than 12,000,000 tons, which were shipped from New York, Philadelphia, Baltimore and Norfolk. Exclusive of the freight carried in the regular coastwise steamers, it is estimated that the other commodities aggregated during the year some 5,000,000 tons, making a gross total of about 18,000,000 tons.

From these statistics, and the diversified points of origin of traffic, it will be seen that this canal is of national importance. Although nominally the bulk of the cargoes that will use it northbound start from New York, that port is not the originating point. The cargoes represent the produce of the many states seeking their market through a convenient channel—coal from Pennsylvania and West Virginia, tobacco from Virginia and the Carolinas, timber from Georgia, cotton from the whole of the great South. It is an enterprise in which every state on the Atlantic seaboard, from Maine to Florida and Texas, is interested.

If the volume of traffic already in existence is so great, and the saving in distance, delay and danger of such importance, the question naturally arises why, after 300 years of agitation, the canal was not built before. The answer to this very natural question will be found in the change that has been taking place in water transportation, a change which has made it possible for the state of New York to throw away its enormous investment in the existing canal system of the state and build an entirely new system from Lakes Erie, Ontario and Champlain to Albany, at a cost of over $100,000,000.

As long as the coastwise traffic was controlled by schooners, with a recognized unknown length of journey and an amount of delay impossible to forecast, the value of the distance and time saved was not of so much importance as to overcome the expense to a sailing vessel in traversing the more or less narrow waters of Buzzards bay and being towed through the canal. Steam, however, within the last few years has been making the same inroads into the methods of coastwise traffic that it has already made in ocean traffic, so that the schooner is following in the footsteps of the picturesque clipper ship, and is giving way to the tug and tramp steamer.

As soon as a vessel owner adopts as a motive power an agent that will enable him to send his vessel on a schedule he at once begins to take account of delays, and places a money value against the time lost. This method of reasoning—and it is sound—warrants the expenditure of large sums in the improvement of waterways, such as the Cape Cod canal, that would not have been, and were not, justifiable one or two decades since.

To-day the greater part of the coal traffic between New England, New York, Philadelphia and Norfolk is handled in barges, usually two or three in number, behind an ocean-going tug. To show the extent to which the new methods of transportation are superseding the old, the statistics compiled by the chamber of commerce for the port of Boston each year are at hand. In 1902 there arrived in Boston from domestic ports south of Cape Cod 1,033 steamers, 1,209 sailing vessels, 909 tugs and 1,879 barges; total, 5,030. In 1906, four years later, there were 1,148 steamers, 900 sailing vessels, 1,166 tugs and 2,458 barges; total, 5,672. The aggregate vessel tonnage of the former years was a little over 5,000,000 tons, and of the latter nearly 7,000,000 tons.

The thing that strikes one in these statistics is the small increase in vessel number and yet the large increase in vessel tonnage, indicating an increase in average size of unit. While the total number of steamers remains substantially the same, sailing vessels have decreased 25 per cent. in number and the barges have increased more than 33 per cent. in number.

In 1902, of the total entrances at Boston, steamers comprised 20.5 per cent., tugs 18 per cent., sailing vessels 24 per cent. and barges 37.5 per cent. The same division in 1906 was: steamers 20.3 per cent., tugs 20.6 per cent., sailing vessels 15.8 per cent. and barges 43.3 per cent. Or, taking the United States government figures for 1905 and comparing them as a matter of convenience with the census returns for the year 1899, of the total tonnage carried to Boston, 53.9 per cent. went in steamers in 1899, and exactly the same in 1905; but while barges carried but 21.1 per cent. in 1899, they carried 31.3 per cent. in 1905, and the sailing vessel tonnage, which had accounted for 25 per cent. of the whole in the first year, had fallen to 14.8 per cent. in the second.

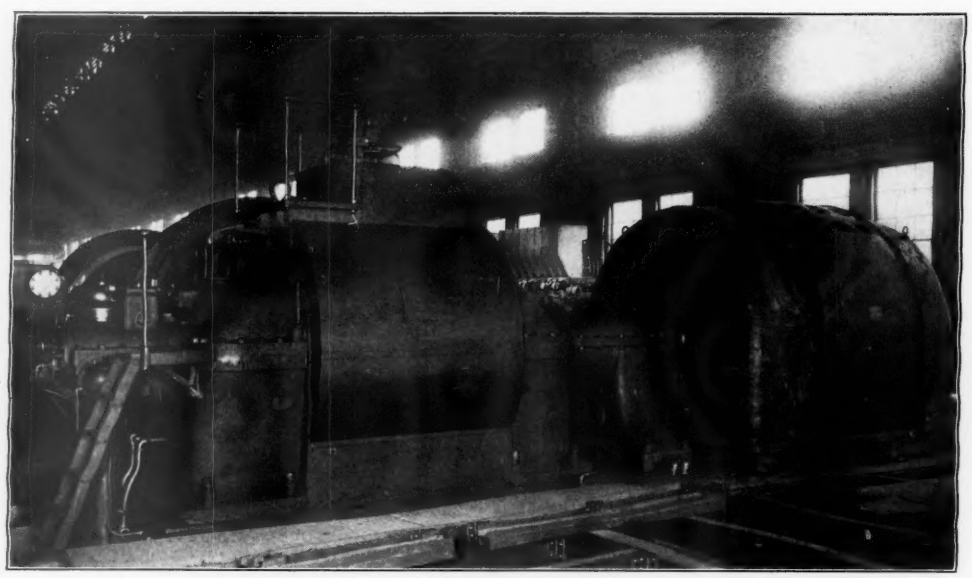
This same general change in traffic conditions will apply equally to all waterways that are to be hereafter constructed, and any waterway that is either to be constructed anew or to be made by the improvement of existing conditions, must be undertaken with the view of its exploitation by vessels whose power will be for the most part something other than sails. With the Cape Cod canal established, the great source not only of danger but of delay will have

been removed, and the towing companies, whether private or part of the various coal companies' equipment, can estimate with reasonable certainty upon the time of departure and arrival of their tugs, in fact with a much greater certainty than for similar shipments by rail.

Its national rather than local character is to be impressed on the attention of this convention, as this canal will do more than make a water route from New York to Boston. It will at once, by means of the Raritan, Delaware and Chesapeake and other canals, complete an inside route safe at all seasons for all boats from North Carolina to Maine, and that without a single dollar more to be invested by the nation or any state. From that point the labors of this convention can be exerted to deepen, widen and develop the existing links and construct others that are now lacking, so that this inside route may be continuous and of sufficient size for modern requirements. To this end not only must canals be built and small rivers enlarged, but the attention of those in authority must be directed to the further increasing of the capacity of the limiting conditions of some of the main arteries. The port of New York is the country's largest gateway. The general government has been at work for years, and has at last completed a new deep channel to sea. That channel is, however, for foreign commerce. The harbor has another entrance from the sound through the East river; this is the channel for internal commerce. It is the channel on which three states—New York, Connecticut and New Jersey—look directly, and it is the one used chiefly by the domestic ocean commerce of the Atlantic states. Although much improved over conditions existing twenty years ago, it is still much restricted by islands, reefs and narrow channels. If any great inland route is to be established it becomes the throat where all traffic will be congested; it is the one place which all are interested in having developed; it is one of the improvements to be most urged by this convention upon the national authorities.

Westinghouse Double-Flow Steam Turbines.

The turbine equipment of the Brunot Island station of the Pittsburgh Railways consists of one 3,000 k.w. and three 5,000 k.w. Westinghouse double-flow units. The smaller unit has been in successful operation nearly one year; the larger ones are in course of erection. Each turbine is connected by a short and direct exhaust duct to an Alberger condenser of the centrifugal jet type. Both circulating and discharge pumps are mounted on the same shaft and driven by a Westinghouse compound, single-acting engine. Both condensers and pumps are beneath the engine room floor between the turbine foundations. A steam-driven, two-stage, dry air vacuum pump is also provided for each turbine. Cooling water is pumped to the condensers from an intake tunnel extending the length of the power house, at one side of the foundations, and the discharge from the condensers empties into a similar tunnel parallel to the intake. There is an adjustable gate in the intake tunnel leading from the screen house to a large central well in which the water level may be maintained at the desired point irrespective of the level to which floods may raise the Ohio river. Each unit rests on reinforced concrete plates supported entirely by six reinforced concrete columns, giving ample space around the condenser.



Double-Flow Turbine Direct Connected to Generator.

The principle of the double-flow turbine is not new, the original Parsons turbine, built in 1880, being of this type. Its advantages, however, can be best brought out only in large machines. For turbines above 5,000 k.w. capacity, the double-flow construction will become standard in all Westinghouse work. In sizes below 3,000 k.w., the Westinghouse-Parsons single-flow construction remains standard.

The low-pressure double-flow turbine consists simply of two similar Parsons turbines placed end to end, taking steam at the center and exhausting at both ends. The axial thrusts are balanced under all conditions of pressure, vacuum and load, without the use of dummy or balance pistons. The high-pressure machine is directly evolved from the low-pressure by adding a high-pressure impulse element mounted at the center of the rotor. This element is analogous to the high-pressure cylinder of a triple expansion reciprocating engine.

Steam enters the turbine through a flanged opening in the lower half of the casing, from which it is piped directly to nozzle blocks. In the illustration, the nozzle block is shown at the top, but it may be located at any point in the periphery nearest the inlet. Expanding in suitable nozzles, the steam strikes the impulse blades, enters the impulse wheel chamber, and is distributed evenly around the casing so as to enter around the entire periphery of the rotor, the intermediate Parsons section of the turbine. As in the single-flow turbine, the steam then divides along two separate paths, one-half entering the left-hand section of low-pressure Parsons blading, the other passing through the interior of the rotor shell which forms the connecting passage to the remaining low-pressure section of Parsons blading at the right-hand end of the turbine. Discharging from the last rows of low-pressure blading, the steam passes into the exhaust connections and to the condenser in the usual manner.

As the same pressure exists on both sides of the impulse wheel disc this is not subjected to any end thrust and requires no balancing. The difference of pressure between the inlet and outlet of the Parsons intermediate section is balanced by a dummy piston of moderate dimensions, located between the impulse wheel and the right-hand low-pressure section.

All double-flow cylinders are made in two parts, the upper and lower halves each being a one-piece casting. The design is symmetrical throughout, without longitudinal flanges except those at the center required for bolting the two parts together. The castings are first rough-bored, after the flanges have been planed and drilled, and are then "seasoned" with high-pressure steam for a number of hours to remove any local casting strains in the metal. They are then given the finishing cut, assembled, and with boring bar running in the bearing housing so as to insure a truly concentric bore. Manholes are provided at each end of the cylinder for interior examination, and relief valves are fitted in each of the manhole covers to prevent the pressure in the exhaust passages rising to a dangerous point in case of failure of the condensing apparatus and sticking of the atmospheric relief valve.

A Y-connection fitted with two corrugated copper expansion joints below the base of the turbine connects the separate exhausts to the main exhaust nozzle. An atmospheric exhaust nozzle opens out of the side of the exhaust "Y" to permit non-condensing operation.

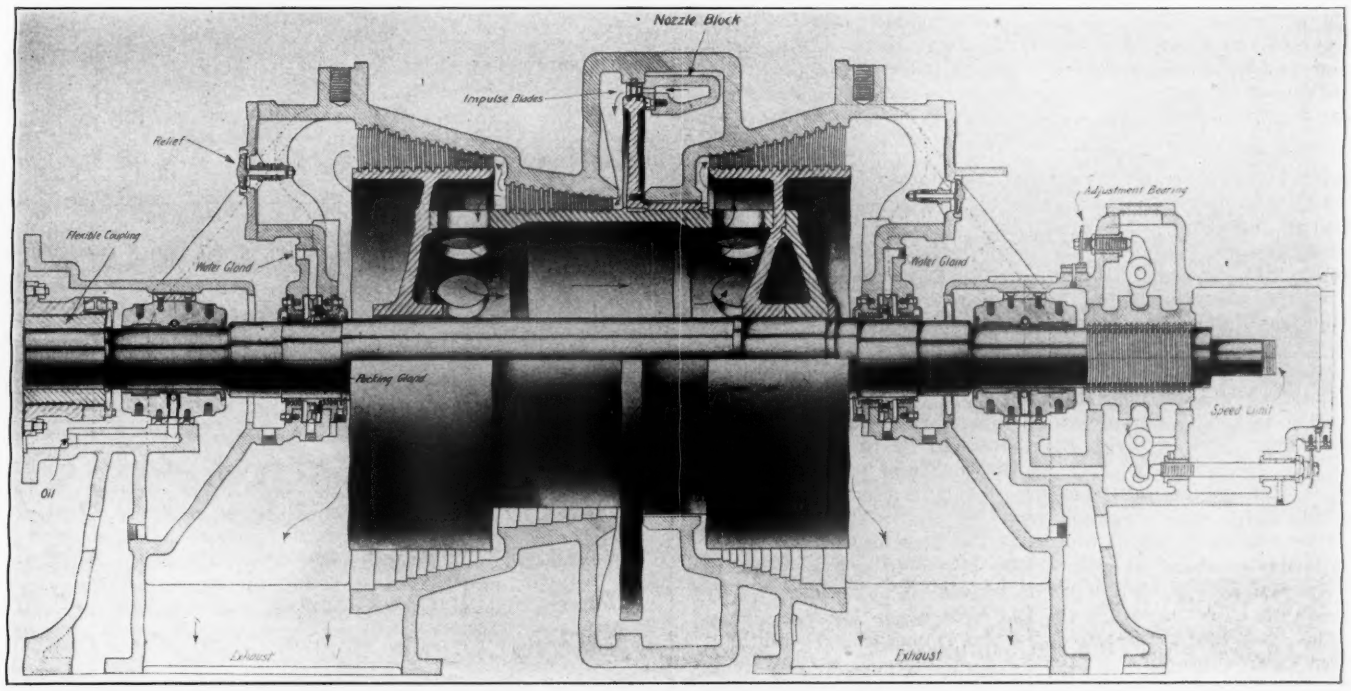
The rotor consists of five cast-steel members mounted on a through shaft. The shaft carries its load at one-third distance from the points of support, thus permitting a lighter shaft than required for distributed loading and greatly lessening the chances of deflection. The rotor is pressed on the shaft and locked at one end, and to the opposite end is fitted a bronze bushing surrounding the shaft, permitting it to move axially with any unequal expansion of shaft and rotor body.

The impulse element consists of a flanged cast steel disc forced on to the rotor body with a pressed fit and securely keyed. The flange at the base is grooved and forms the dummy or balance piston for the intermediate Parsons section. A typical arrangement of blading and nozzles is shown herewith. The nozzle block is an independent casting separate from the turbine cylinder. Receiving steam from the governor valve, this restricts high pressure and high temperature to a comparatively small casting which is free to expand and contract with changes of temperature and may easily be designed with ample strength. As the steam is not expanded in the impulse element to less than about half of the initial pressure, divergent nozzles are unnecessary and simple straight-sided nozzles are used. The entire nozzle block may be removed in one piece, and the nozzle walls may be readily renewed if necessary independently of the block. As almost no difference of pressure exists on the two sides of the element, the area through the bucket increases to provide for the decreasing steam velocity in each rotating wheel. As in all high-pressure impulse turbines, the nozzle

blocks cover but a small portion of the periphery of the impulse wheel, so that ample space is left around the remaining portion of the wheel to permit the free circulation of steam in all parts of the impulse wheel chamber before entering the Parsons element.

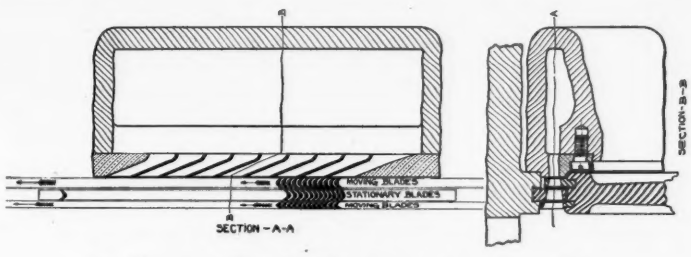
Except for the division of the low-pressure Parsons section, this part of the turbine is the same as the single-flow construction. The diameters of the low-pressure section are such that the same size blades can be used in both intermediate and low-pressure sections, thus simplifying the blading considerably.

No one metal has all the physical characteristics desirable for blading material. But recently a special, compound metal has been developed, which is exclusively used in Westinghouse turbines. This material, known as "Monnot," or duplex metal, consists of a steel core covered with a thin copper sheathing so welded to the steel



Westinghouse Double-Flow Steam Turbine.

that the blades may be drawn cold from the original ingot into the required finished section without in any way affecting the bond between the copper and steel. Experiments have shown that pure copper offers the maximum resistance to chemical corrosion resulting from bad feed water carried over in the steam during priming. At the same time the integrity and strength of the steel core is maintained. The original method adopted for reinforcing long blades was to insert a heavy brass wire in saw slots cut in the entrance edge of the blade, the brass wire being securely laced to the blades by a thin copper wire, and the whole then rigidly brazed together. An improved blade lashing is now used in all Westinghouse turbines. Comma-shaped holes are punched in the blades at any desired point of reinforcement. The blades are then strung



Sections of Nozzle Block and Impulse Blades.

on a comma-shaped lashing wire laced through these holes. After the blades have been caulked into the rotor or stator, the tail of the lashing is sheared over by a tool, wedging the tail of the lashing into the contracting space between the face and back of the adjacent blades, acting as a strut, while the lashing wire itself acts as a tie, thus securely interlocking the blades and preventing vibration. The short section remaining in the blade after being sheared off acts as a key to prevent a broken blade from swinging out and injuring adjacent rows.

A water-sealed gland is fitted on each end of the turbine shaft where it passes through the exhaust casings. This packing consists of a small centrifugal pump propeller running in an enclosed chamber to which water is supplied under a head of about 10 ft., which is slightly in excess of the head due to the centrifugal force acting on the water in the impeller blades. At starting, any external leakage water is caught in circular troughs and drained away. This gland always maintains a solid mass of water around the periphery of the impeller, which prevents the entrance of air to the condenser or the escape of steam to atmosphere when running non-condensing.

Picked Up on the Road.

BY GULF.

The following story concerning a fireman comes from the South, where a good many firemen are of very dark complexion, and are supposed to have very hard heads. This one, like most darkies in stories, bore the name of Sambo. He was a fireman on the principal railroad of the South. His entire term of service had been spent on a switching engine, but one day, in an emergency, he was called to fire on a passenger train. The passenger engineer gave him such instructions as he could in the short time at his disposal, and in particular told him that on a passenger engine one of the duties was to watch out for the mail bags hung out on the cranes at non-stopping stations to be taken up by the train while running at full speed. Sambo remembered this part of his instructions very faithfully and the engineer gave no further thought to the matter until, after having passed a half dozen mail stations, he was stopped by the conductor, who, at the request of the mail clerk, had pulled the air signal and then had come forward to find out what was the matter with the mail bags, no bag having been picked up at any one of the six stations which had been passed.

"Dere dey is!" said Sambo, pointing to the back part of the coal pile on the tender. He had caught each bag as he came to it. At this point the story comes to an end. The supposition is that he caught the bags by swinging out far enough to strike them with the port side of his cranium. By this process the shock was sufficiently "absorbed" to allow of the bag being grabbed and pulled in.

Speaking of the South reminds me that in returning from the South to New York one passes through Washington, a city which has just been furnished with a grand and imposing new station. The main waiting room of this station, 220 ft. long, occupies the central part of the immense building, and its ceiling consists of a magnificent and richly ornamented arch nearly 100 ft. high. At night this arch, which is decorated in white and gold, is lighted wholly by reflection from electric lights hidden out of sight at the springing lines on either side of the room, making a very pleasing effect. My reason for bringing the subject up at this time, however, has to do with the waiting room in the day time, rather than at night, and my topic is the train announcer. The reverberations completely destroy the effect of his work. Everything that he says is followed by echoes so numerous, loud and far reaching that nine-tenths of the people in the room have no idea what the man says. This particular train caller never was a shining success, even in the smaller room of the old station at Sixth street, but his uselessness is now intensified tenfold.

Possibly the satisfactory announcement of trains in a room of

this kind is out of the question; it may be that the best elocutionist in the world would find himself baffled by the utterly bad acoustic properties of such a great space arranged in that shape. The main room of the Grand Central Station at New York, considerably smaller than this great hall at Washington, has proved a difficult proposition for the shouters there, and they claim that they have to wait a full second or more between every group of two or three words and the group next following, so as to give the echoes a chance to die out. If there is no remedy for this difficulty it would seem as though we might as well settle down to the conclusion that the only useful function of a train shouter is to call the attention of people in the room, at suitable hours, to the fact that it is time for at least some of them to ask themselves whether they should not be seeking their seats in the cars. An intelligent porter, of the right disposition, may do much good in a waiting room by answering questions which are asked of him by individual passengers, but to shout, where most of the shouting is unintelligible is only an annoyance to everybody within hearing distance. He would do better to ring a bell or beat a drum, and then let the people come and ask him what news he has to impart.

Another interesting feature of the new station at Washington, which confessedly has been built partly for the purpose of elevating our capital to the level of other Imperialistic capitals, such as are to be found in Europe, and to give our most beautiful city a dignity which it never before enjoyed, is the magnificent scale of rates charged at the package room. These are fully in keeping with our present era of expansion. To leave a Gladstone bag, an overcoat and an umbrella there for 20 minutes costs 30 cents. The charge would be no higher for a whole day, but it is not unfair to state the case in this way; it is not extreme; for a great many people desire to avail themselves of this storage room for short periods of time. How much profit there will be in the operation of a busy coat room 8 ft. x 10 ft., in the course of a year, at rates like this, I will not stop to compute; but the average passenger will probably agree with a remark made by one of the station employees, who expressed the opinion that the directors of the Washington terminal company expect, in the course of a few years, to pay for the station out of the profits of the package room. Why should not this petty extortion be laid before our enlarged, reorganized and energetic interstate commerce commission? While it seems hardly the thing to ask seven dignified judges to give their time to the consideration of such a picayune question as that which just now grieves me, it is to be borne in mind that an important principle is involved. In a number of cities the Pennsylvania and other railroads have maintained carriages, for the purpose of taking passengers to and from their stations, at a loss to the company, the theory being that the accommodation of the passengers was the paramount consideration. This principle should (and does) apply to a coat room.

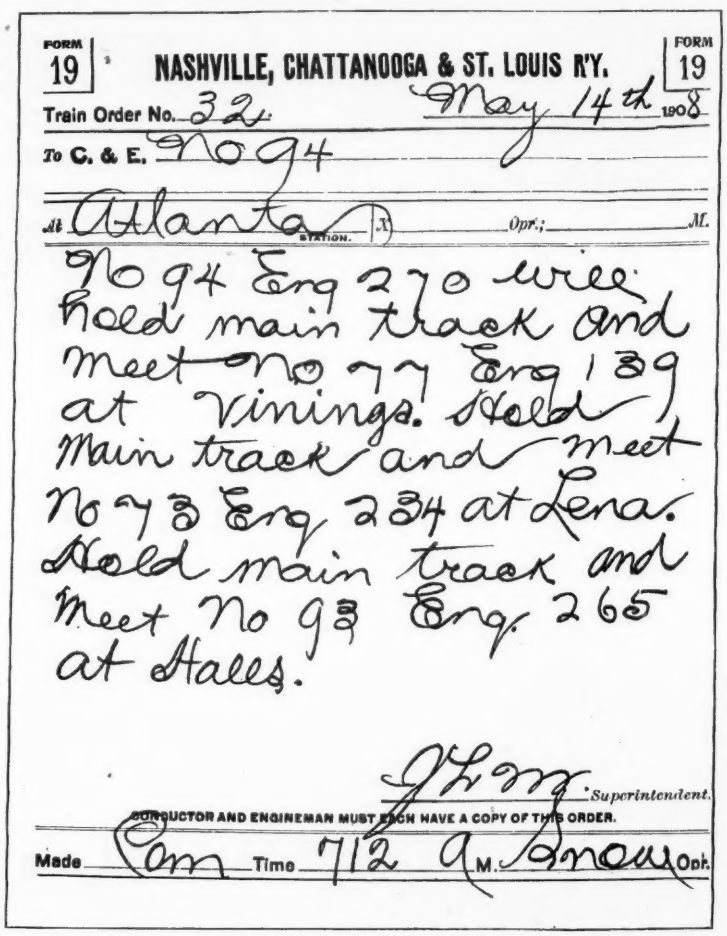
Congress itself sets the example of giving attention to small affairs by devoting its own time to the details of administration in the District of Columbia; and the House of Representatives has lately made a requirement under which the interstate commerce commission will have to follow the Congressional example; I mean the law concerning a street railway extension in Washington, which includes a proviso that the new railway must be managed under the supervision of the commission. If these ten-thousand dollar jurists can devote their time to deciding what kind of frogs shall be used at a street railroad junction, or how many cents per million may rightfully be paid for printing transfers (with a department store advertisement on the back) it will not be out of the way to ask them to relieve the irritated passenger who is held up by the coat room buccaneer.

Car Surpluses and Shortages May 13.

The Committee on Car Efficiency of the American Railway Association, Arthur Hale, Chairman, has issued Bulletin No. 23, giving a summary of surpluses and shortages of freight cars by groups from October 30 to May 13. The total surpluses of cars reaches 404,534 in this report, being a decrease of 9,071 from the report for April 29. The largest decrease is in box cars, although there is almost as great a decrease in coal and gondolas. The number of idle flat cars decreased slightly, while the number of miscellaneous cars idle remained about the same. The Eastern, Northwestern and Canadian groups show the largest percentage of decrease, while the New England, Middle Western and Pacific groups show increases. In the Middle and North Atlantic groups the reports for individual roads show some improvement, which is offset, however, by increases on other roads in these groups, leaving the total about the same as on April 29. The summary for 163 roads is shown in the double column table.

A Clearly Written Train Order.

The train order shown herewith, *reduced one-half in width and height*, is published for the purpose of putting on record, as a matter of history, the fact that legible penmanship is not a lost art in the railroad service. On many roads the typewriting machine has come into use to a considerable extent for making train orders, but at places where a machine is not available, it is refreshing to find an operator who can produce readable copy.


FORM 19

NASHVILLE, CHATTANOOGA & ST. LOUIS R'Y.

FORM 19

Train Order No. 32. May 14th 1908

To C. & E. No 94

At Atlanta STATION. X Opr.; M.

No 94 Eng 270 will hold main track and meet No 77 Eng 189 at Vinings. Hold main track and meet No 93 Eng 234 at Lena. Hold main track and meet No 93 Eng 265 at Halls.

J Lyon Superintendent.

CONDUCTOR AND ENGINEMAN MUST EACH HAVE A COPY OF THIS ORDER.

Made Com Time 712 A.M. Brown Opr.

On the Nashville, Chattanooga & St. Louis train orders are carefully and constantly inspected by a sharp-eyed man from headquarters, and not only is slovenly penmanship rigidly subdued, but any tendency on the part of despatchers to use ambiguous wording also is nipped in the bud.

To write this order in three separate paragraphs, which would be a marked improvement in orders of this kind, the operator would have had to write a smaller hand.

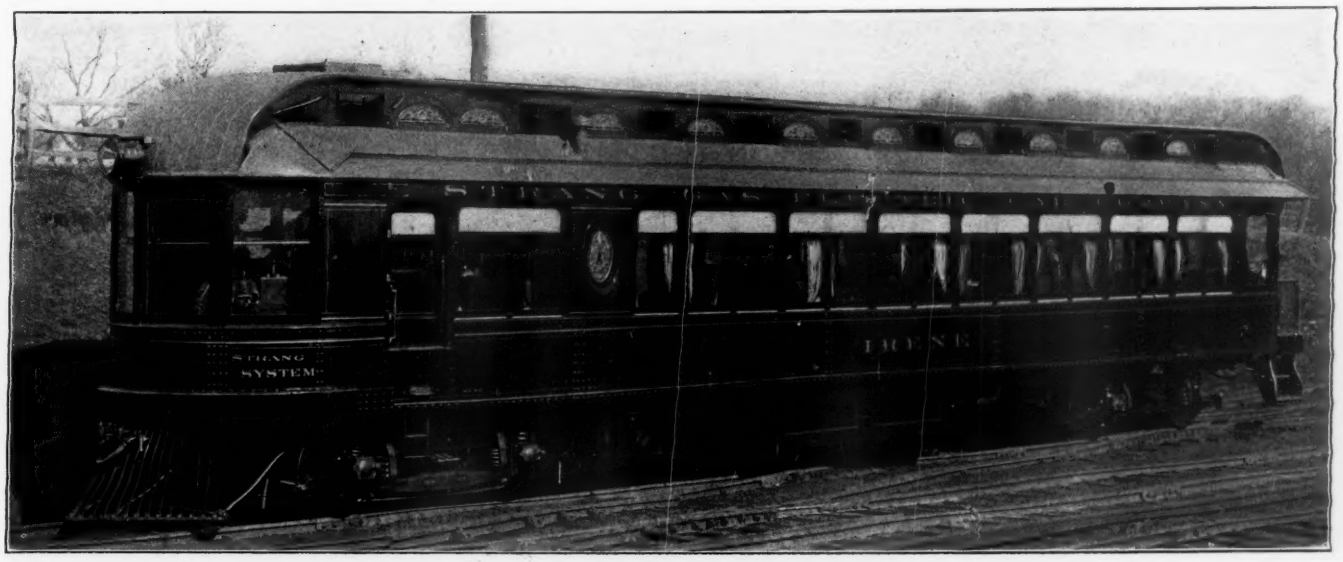
Surpluses and Shortages Bi-Weekly, from October 30, 1907, to May 13, 1908, Inclusive.

	Number of roads.	Surpluses. Box.	Flat.	Coal, gondola and hopper.	Other kinds.	Total.	Shortages Box.	Flat.	Coal, gondola and hopper.	Other kinds.	Total.
May 13, 1908	163	143,822	22,949	183,041	54,722	404,534	100	33	16	10	159
April 29, 1908	159	147,971	24,350	186,742	54,542	413,605	145	42	16	64	267
April 15, 1908	153	138,065	23,811	160,205	53,689	375,770	83	7	1	55	146
April 1, 1908	158	111,748	24,774	120,669	50,316	307,507	319	117	8	84	528
March 18, 1908	160	103,509	25,122	119,205	49,206	297,042	533	151	250	73	1,007
March 4, 1908	162	103,905	27,232	139,223	44,632	314,992	943	19	600	57	1,619
February 19, 1908	161	113,776	30,088	134,217	44,432	322,513	697	141	249	162	1,249
January 22, 1908	161	124,622	27,328	142,338	48,292	342,580	392	132	79	135	738
December 24, 1907	158	87,714	14,740	64,556	42,300	209,310	187	81	191	265	724
November 27, 1907	160	16,246	3,645	10,028	10,429	40,348	11,908	868	2,964	2,224	17,964
October 30, 1907	161	786	600	1,285	1,275	3,946	61,592	3,546	15,987	9,632	90,757

Strang Gas-Electric Car Irene.

The J. G. Brill Company, Philadelphia, Pa., recently built for the Strang Gas Electric Car Company, New York, the car shown in the accompanying illustrations.

The Strang system consists of a four-cycle gas engine, direct-connected to a d.c. generator, supplying current to the truck motors. Normal requirements are met by the generator, the peak loads being carried by additional current supplied from a storage battery, which is charged during stops or when coasting down grades. While current is being supplied to the storage battery only, the engine is automatically throttled on reaching the capacity of the battery. In case of accident to the gas engine, it is claimed that the car can run 15 miles on current from the battery alone.



Strang Gas-Electric Car "Irene."

The Irene is equipped with multiple unit control, so that the car can furnish current to motors in cars coupled to it. As a motor car it can haul three trailers, seating 75 passengers each.

The car is built of steel, with an interior pleasing in design and finish. Just behind the engine room the forward compartment is furnished with transverse seats, upholstered in red leather. The rear half of the car has comfortable wicker chairs, similar to those used in Pullman cars. The car is heated from the engine jacket, water being circulated by means of a motor-driven centrifugal pump, through heating pipes inside the car. During the summer season, the jacket water is passed through radiators placed on the roof of the car.

Interior, Strang Gas-Electric Car "Irene."

The first Strang car was described in the *Railroad Gazette* of Feb. 23, 1906. This car was 52 ft. 9 in. long, accommodating 41 passengers; the Irene is 66 ft. long and carries 75 passengers. The new car is designed for a maximum speed of 55 miles an hour, the average consumption of gasolene is 0.6 gallons per mile and enough gasolene is carried for a 200-mile trip. The original car had a maximum speed of 50 miles an hour; it used an average of 0.45 gallons per mile and carried enough for a 225-mile trip. The electric equipment of the first car consisted of a 50-k.w., 250-volt, d.c. generator, 400 r.p.m.; two 50 h.p. series wound motors of the street railway type; two K-13 controllers and a storage battery of 112 cells, 200 ampere-hours capacity. The Irene has an 85-k.w., 250-volt, d.c. generator, shunt wound, of 425 r.p.m.; two 100-h.p., 250-volt, series wound interpole motors and a storage battery, Plante type, of 112 cells and 300 ampere-hours capacity. The six cylinders of the first car were mounted alternately at angles of 90 deg. to each other and 45 deg. from the verticle. The six cylinders of the engine of the Irene are all vertical.

Mikado Locomotive for the Kentucky & Tennessee Railway.

The Baldwin Locomotive Works have recently completed for the Kentucky & Tennessee Railway a Mikado type locomotive, which possesses a number of interesting features. This engine is intended for comparatively short hauls on a line having grades of 4 per cent., which occur in combination with curves of 20 deg. and not compensated. In order to enable the locomotive to easily enter sharp curves when running in either direction the 2-8-2-wheel arrangement is employed. The piston stroke is comparatively short, and by using driving-wheels of small diameter a tractive force of 40,900 lbs. is developed, while the rigid wheel base is only 11 ft. 6 in.

The leading truck is of the usual swing bolster design, with radius bar, and is equalized with the first and second pairs of driving-wheels. The two remaining pairs are equalized with the rear truck, which is of the Rushton type, with inside journals. A half elliptic spring, having arms of unequal lengths, is used in the equalization system between the rear driving-wheels and the back truck.

The main frames are of cast steel, with rear sections of the same material and double front rails of wrought iron. The splice between the main and rear sections is located back of the rear driving-wheels, at which point the frame is supported by the spring previously mentioned. The pedestal binders are lugged and bolted to the pedestals.

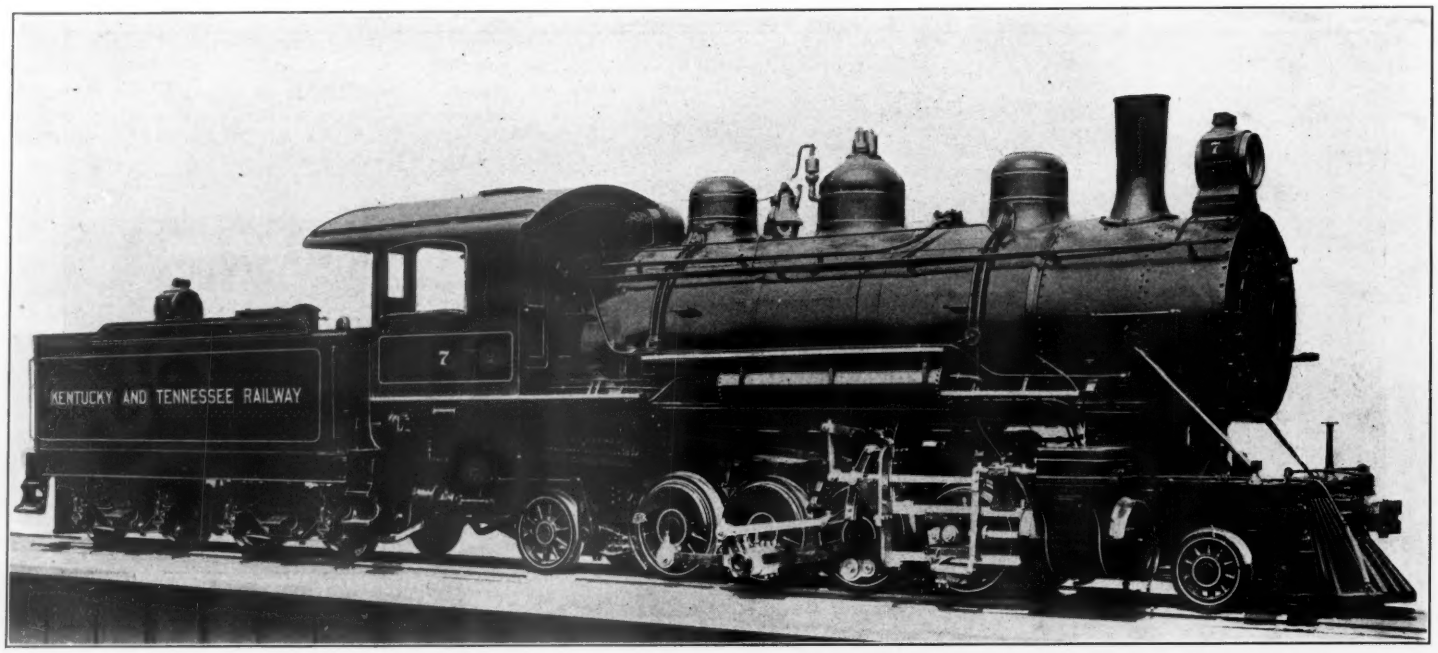
The cylinders are single expansion, equipped with balanced slide valves, which are actuated by the Walschaerts valve gear. The link is of the built-up type, and is supported by a cast steel bearing which is bolted to the back of the guide yoke. The valve rod is supported by a bracket, which is bolted to the top guide bar. There is sufficient room in this design to place the combining lever in front of the crosshead, and thus use a short valve rod, which is substantially supported, adding to the rigidity of the motion. The reverse shaft is placed in bearings, which are bolted to the guide yoke. The radius rod is extended back of the link, and is suspended at the rear end. The valves have an outside lap of 1 in. and are line and line on the inside. They are set with a maximum travel of 5½ in. and a constant lead of $\frac{3}{16}$ in.

The guide yoke is made in three pieces, the lower extension, on each side, being securely bolted to the main section. This feature

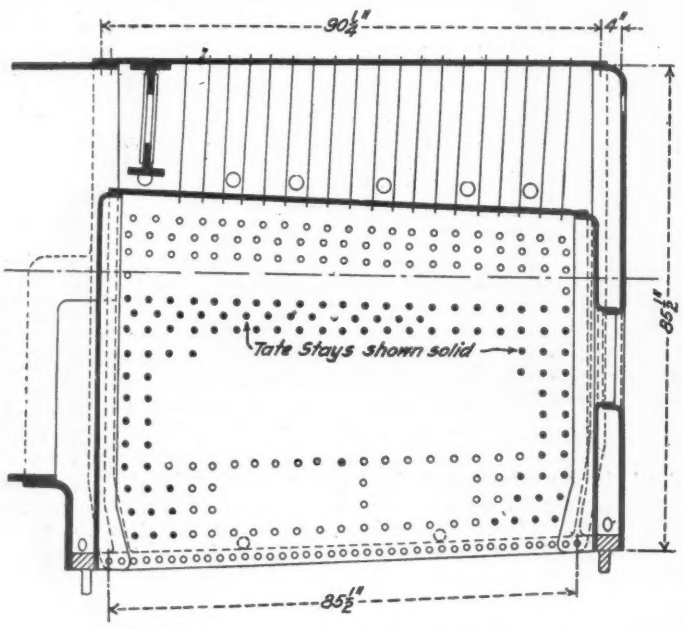
adds to the convenience in handling these parts. The guides are of the alligator form and the crossheads have cast steel bodies and bronze gibs.

The boiler is of the straight top, radial stay type, with wide firebox, having a vertical throat sheet and back head. The mud ring is supported on sliding shoes in front and a buckle plate at the rear. The front end of the crown is supported by one I bar, and 330 flexible staybolts are located in the breakage zone in the throat, sides and back, and here attention is again called to a point that has been repeatedly alluded to in these columns, namely—the variations in the use of the flexible staybolt and the tendency to increase the number used. In some engines built for the Wabash the flexible stays came down at the front and back, across the top and filled the triangular space in the throat sheet below the shell down to a horizontal line drawn through the bottom of the same. In this boiler the same area is covered with the addition of a cluster in the lower corners of the side sheets close to the foundation ring and the almost complete filling of the throat and tube sheet with them. In fact, they are used over the whole of these surfaces except in the top row next the shell and at four other points on each side where hollow bolts are used. In the side sheets, owing to the long radius of curvature at the sides of the crown, the top row of the flexible bolts are rather lower than usual, and are but just above the top of the door. The marked feature of the use of the flexible bolts in this instance is to be found in the fact that they are carried all of the way down to the foundation ring at the four corners and across the front. It is usually considered that the foundation ring holds the two sheets so firmly together that the possible variation of expansion in its immediate neighborhood is so slight that flexible bolts would be of no practical advantage. Their use, therefore, in this place indicates a growing conviction of the necessity for a greater flexibility between the sheets than was formerly regarded as essential.

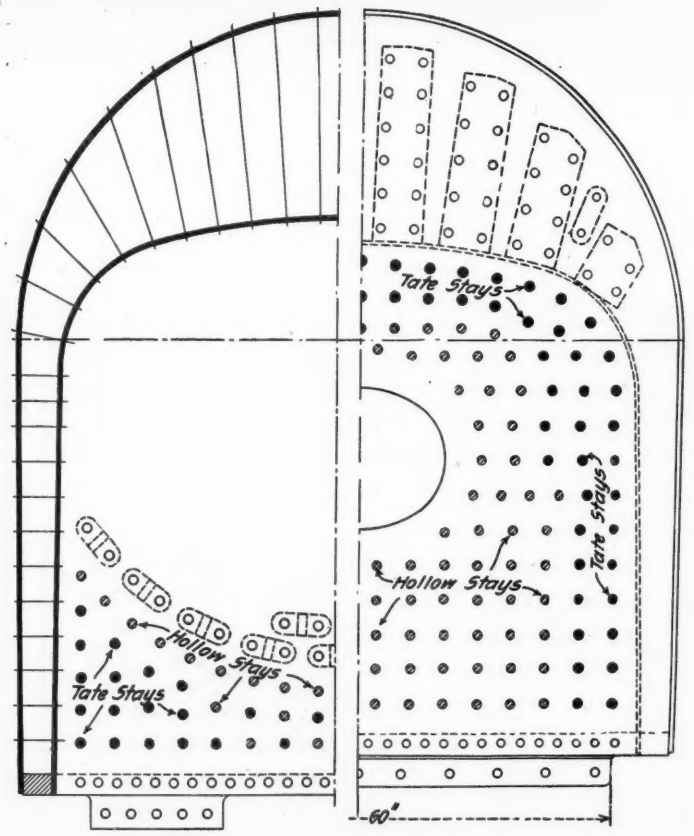
The boiler barrel is built with three rings, the dome being centrally located. The longitudinal seams are welded at the ends, except on the dome ring, where the seam is placed on the top center line and is welded throughout its length on either side of the dome opening. The seam is reinforced by a heavy inside liner.



Mikado Locomotive; Kentucky & Tennessee.



Longitudinal Section of Mikado Locomotive Firebox.



Cross Section and Rear Elevation of Mikado Locomotive Firebox.

The tender is carried on arch bar trucks, which are equipped with cast steel bolsters and chilled cast iron wheels. The tender frame is built of steel channels. A pilot is provided at the rear end.

This locomotive, although not intended for long hauls in main line service, is an interesting example of a design built to operate under difficult conditions. The 2-8-2-wheel arrangement is particularly suitable for roads having light rails and many curves, while it allows the use of a larger boiler than could be applied to a consolidation locomotive with the same weight on driving-wheels.

The following are some of the principal dimensions of this engine:

Cylinder, diameter	21 in.
Piston stroke	24 "

Boiler, diameter shell	72 in.
Boiler, thickness of sheets	¾-in.
Steam pressure	200 lbs.
Firebox, length	90 in.
" width	66 "
" depth, front	66½ "
" depth back	59 "
" thickness, side, crown and back sheets	⅜-in
" thickness tube sheets	½-in.
" water space front	4 in.
" water space sides and back	3½ "
Tubes, material	Iron
" thickness	No. 11
" number	315
" diameter	2 in.
" length	15 ft. 5 "
Heating surface, tubes	2,529 sq. ft.
" " firebox	148 "
" " total	2,677 "
Grate area	41.2 "
Wheels, diameter, driving	44 in.
" " front truck	28 "
" " rear truck	36 "
" " tender	33 "
Journals, driving axle	8½ x 10 in.
" truck	5½ x 10 "
" tender	5 x 9 "
Wheel base, driving	11 ft. 6 in.
" " total engine	25 " 5 "
" " engine and tender	51 " 10 "
Weight on driving wheels	140,050 lbs.
" " front truck wheels	16,350 "
" " back truck wheels	24,000 "
" total engine	180,400 "
" engine and tender	280,000 "
Tank capacity water	5,000 gals.
Tank capacity coal	6 tons
Tractive effort	40,900 lbs.

$$\frac{\text{Weight on drivers}}{\text{Tractive effort}} = 3.42$$

$$\frac{\text{Total weight}}{\text{Tractive effort}} = 4.41$$

$$\frac{\text{Tractive effort x diameter drivers}}{\text{Heating surface}} = 672.20$$

$$\frac{\text{Heating surface}}{\text{Grate area}} = 64.97$$

$$\frac{\text{Firebox heating surface}}{\text{Total heating surface}} = *5.53$$

$$\frac{\text{Weight on drivers}}{\text{Heating surface}} = 52.31$$

$$\frac{\text{Total weight}}{\text{Heating surface}} = 67.38$$

$$\text{Volume of two cylinders, cu. ft.} = 9.62$$

$$\frac{\text{Total heating surface}}{\text{Volume of 2 cylinders}} = 278.27$$

$$\frac{\text{Grate area}}{\text{Volume of 2 cylinders}} = 4.28$$

*Per cent.

Foreign Railroad Notes.

The Prussian State Railroads contracted for 3,000 twenty-ton (44,000 lbs.) coal cars last year and will order 4,500 more this year, of an improved pattern.

The production of petroleum in Rumania has increased greatly of late years and amounted to 7,910,000 barrels in 1907, while no longer ago than 1898 it was only 1,260,000 barrels.

The Chinese have built a railroad 37 miles long from the coast south of Canton to Hsin-ming, notable as being financed and constructed by the Chinese themselves. It is said to pass over a flat country, but to be pretty much made up of curves, introduced to dodge graves, etc.

In the Prussian House of Delegates a motion was adopted asking the government to pass voters free on the railroads from their places of residence to the places where their votes were to be cast, and return, and to put on special trains for this purpose when necessary.

At last the depression in business has reduced the earnings of the German railroads, whose receipts in March were 8½ per cent. less from freight this year than last. The decrease in passenger earnings is largely due to the fact that the Eastern holidays were in March last year and in April this.

Old and New Interlocking at Batavia.

Although railroad signaling is still looked upon as rather young, as regards American railroads, its youthfulness is not extreme after all. The accompanying illustrations, Fig. 1 and Fig. 2, show a Toucey & Buchanan eight-lever interlocking machine, which until a few months ago was in service on the New York Central at Batavia, N. Y. We do not know the exact date that this machine was built, but the first one of the kind was put up at Spuyten Duyvil in 1874 or 1875. Other designs came into use within a few years thereafter. The Batavia machine has now been superseded by a 50-lever all-electric interlocking machine, made by the Union Switch & Signal Company. The old machine after being taken out was set up in the store-room and photographed, as here shown.

The Toucey & Buchanan interlocking was described in the *Railroad Gazette* of October 16, 1875. The unlocking of the lever was done by pressure of the signalman's foot; the downward movement of the treadle tilted the "flop," thus locking or unlocking the proper dog or dogs. The connection between the treadle and the "flop" is shown at *a*, *a*, Fig. 2. The cranks connecting the levers with the locking bars are shown at *a*, *a*, Fig. 1.

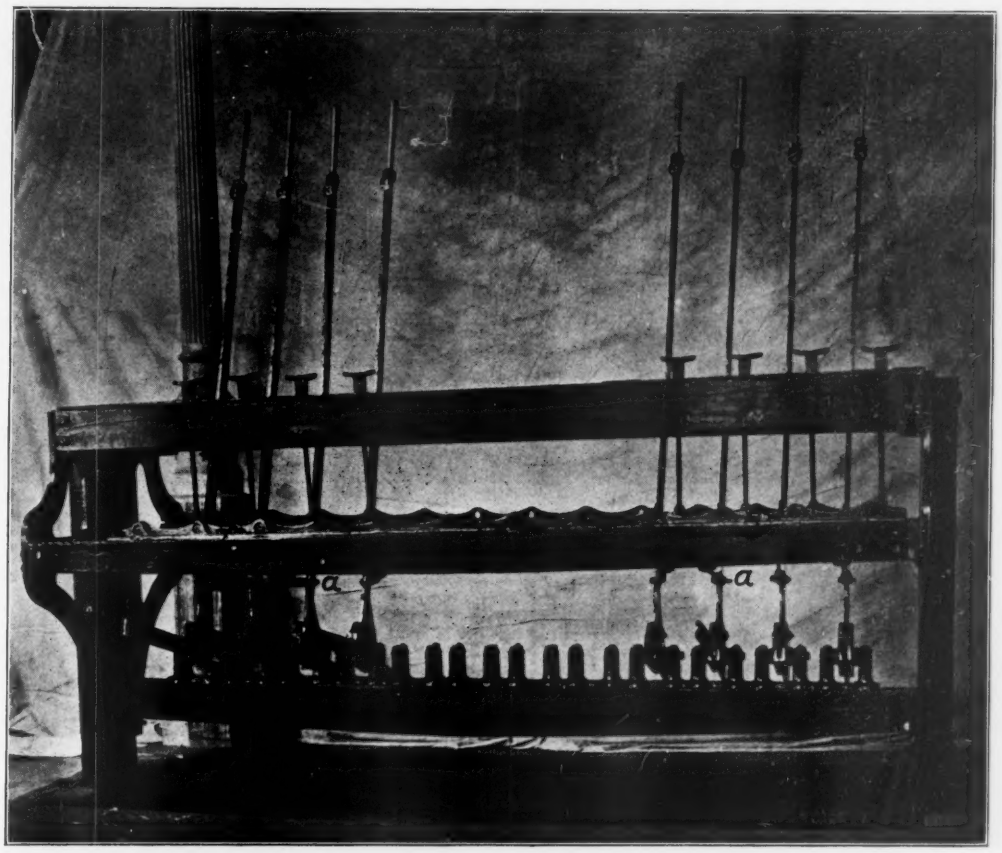


Fig. 1.

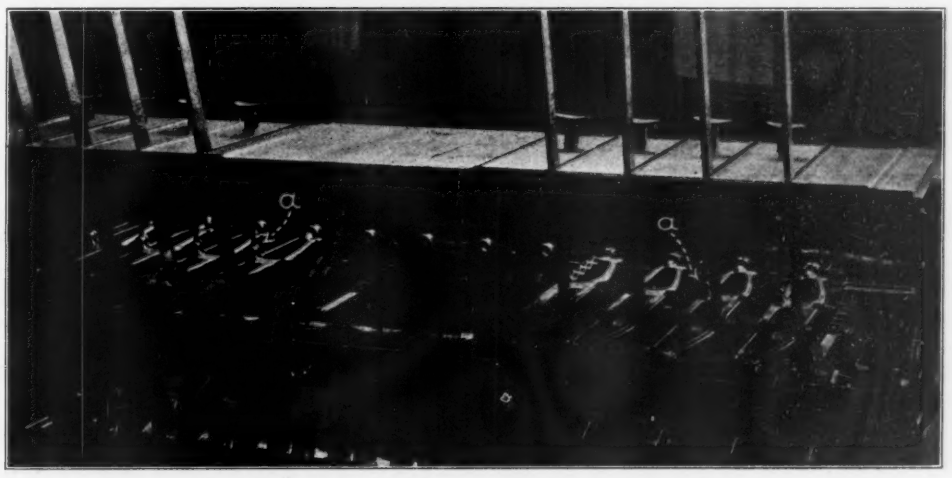


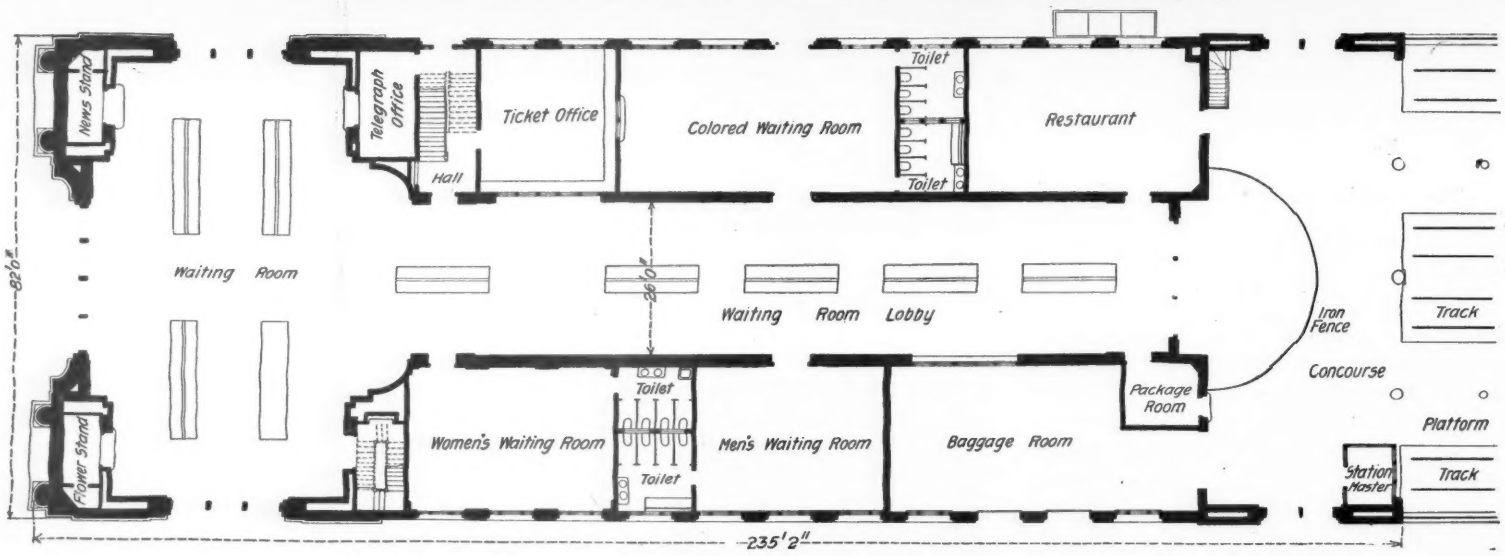
Fig. 2.

Toucey & Buchanan Interlocking Machine.
In service at Batavia, N. Y., about thirty years.

The New Union Station of the New Orleans Terminal Company.

Work on the new union station at New Orleans, La., of the New Orleans Terminal Company, which was begun about the first of June, 1907, is now about completed. The terminal is being built for the Frisco system and the Southern. Preliminary to its construction a large amount of property was acquired, as both the station and the track facilities in connection therewith are on ground not previously used for railroad purposes. As will be seen from the accompanying map of New Orleans showing all the railroads and their passenger terminals, the new station fronts on Canal street, the principal business street of the city, and is quite near the center of the business district. The site was previously five blocks of Basin avenue, a short avenue 172 ft. wide extending from Congo square to Tulane street. The new station occupies 82 ft. of this width, leaving a 45-ft. street on each side, called respectively East Basin and West Basin street. The portion of Basin avenue from Canal to Tulane street gives an open area fronting the station, providing an unusually favorable setting and a wide parked approach to the station two blocks long.

New Passenger Station at Canal and Basin Streets; New Orleans Terminal Company.



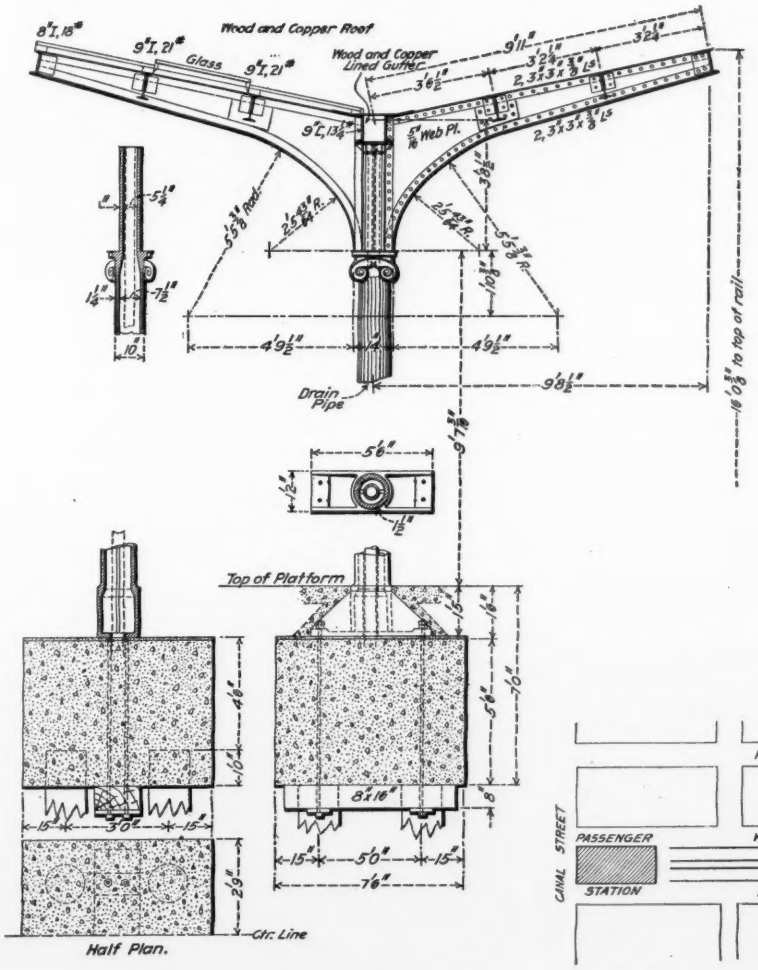
Plan of Passenger Waiting Room; New Orleans Terminal Company.

The station building is 82 ft. wide by 235 ft. long. The style of architecture is a sober treatment of the modern French. A primary aim of the design was to give an impression of openness, in keeping with the function of a station handling large crowds of people. The front of the building is therefore treated as a single large archway flanked by coupled columns and crowned by a high attic carrying an inscription. The main entrance archway is 30 ft. wide by 40 ft. high. It opens directly into the main waiting room, which is 80 ft. long, 40 ft. wide and 52 ft. high to the soffit of the central dome. There is also an archway 30 ft. high at each end of the waiting room, giving entrance from the two side streets. The main motive of the building is thus a large vestibule which can be entered freely from all sides. Each of the side entrances is protected by a marquise for the convenience of passengers using carriage or motor.

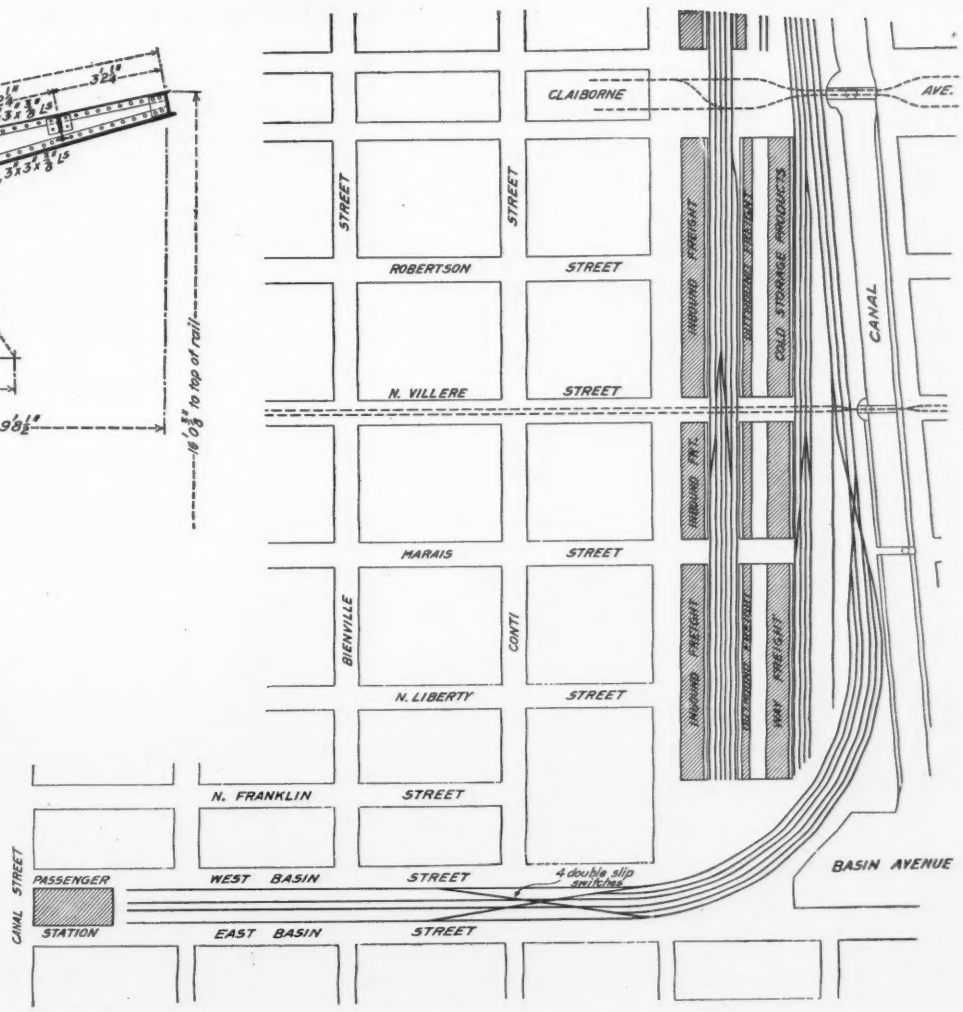
Extending centrally through the building from main waiting room to concourse is a lobby 26 ft. 4 in. wide. It is provided with benches like the main waiting room, which it is intended to supplement. Ranged along the two sides of this lobby are the principal services, including ticket office, restaurant, baggage room, women's retiring room, men's smoking room and colored waiting room, the latter having a separate entrance from West Basin street. The telegraph office, news-stand and flower stand are in the main waiting room.

The concourse is 80 ft. long and 35 ft. wide. It has large doorways leading to the street at each end so that incoming passengers can make their way directly to the street without passing through the station and thus interfering with outgoing passengers.

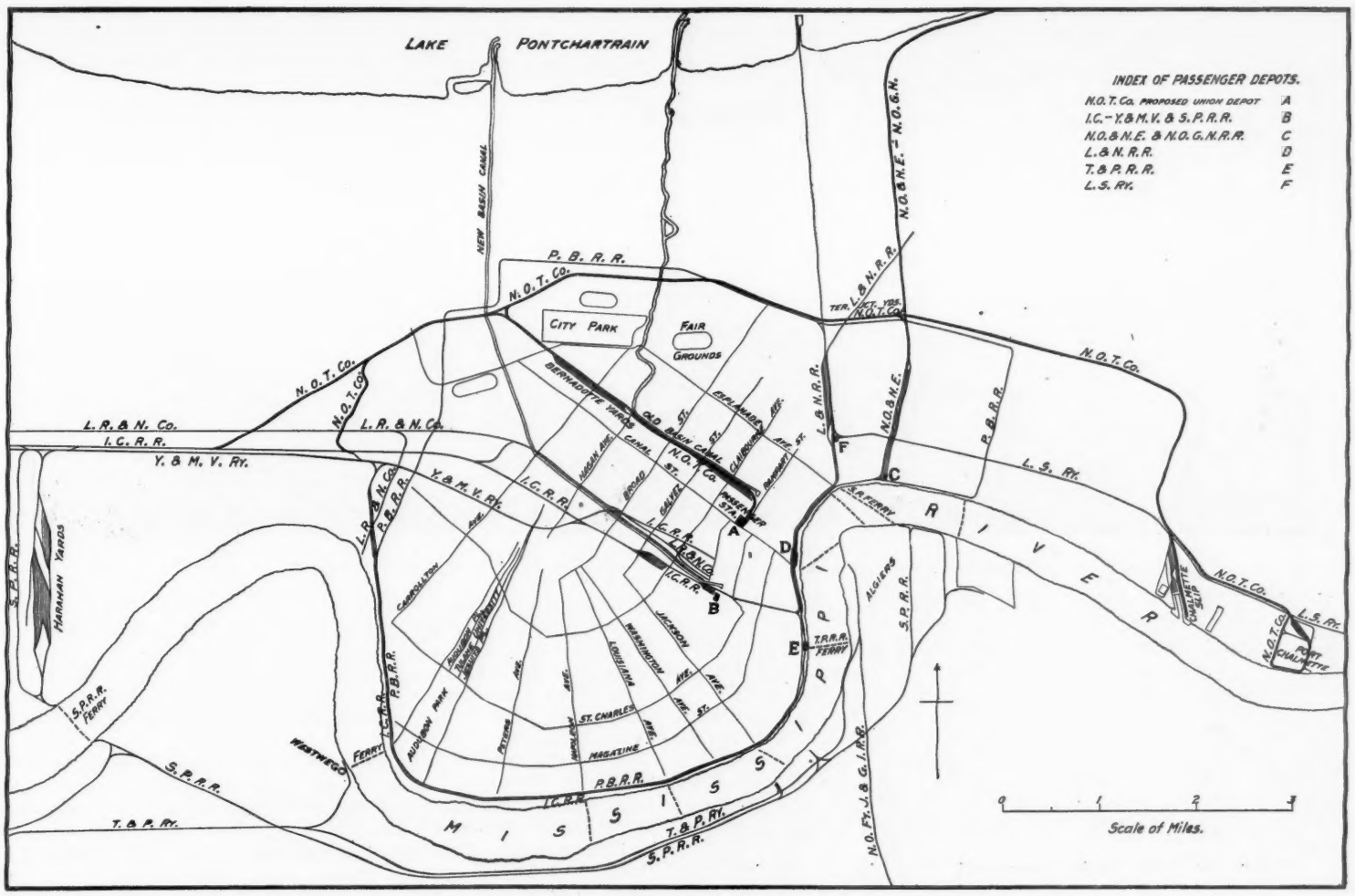
The building will have a concrete foundation resting on piling. A special feature in connection with the foundation is the difficulty of taking care of an old drainage canal 22 ft. wide running lengthwise under the center of the building.



Details of Inverted Umbrella Shed Over Platforms.

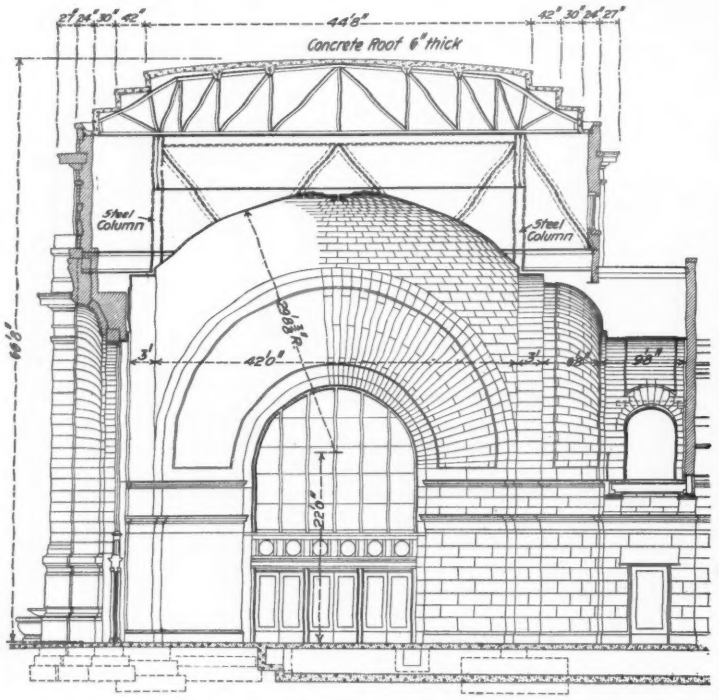


Plan of Freight and Passenger Terminals and Approaches; New Orleans Terminal Company.



Map of New Orleans Showing All Railroad Terminals and Connections.

The Canal street, or main waiting room section of the building, will have its exterior lower portion of granite and the upper part of Bedford stone. The remainder of the building exterior will be brick and stone, the brick being a special gray color to match the Bedford stone. The type of the interior of the main waiting room has already been indicated. There is a large central dome from which a barrel vault extends to each of the four sides of the room. The scheme of treatment is a masonry effect, consisting of marble



Cross-Section Through Dome of Waiting Room, Showing Steel Framing; New Orleans Terminal.

to a height of 12 ft. above the floor, the remainder being done in cement in imitation of light-colored stone to harmonize with the marble. The floor is mosaic tile. The central lobby will have the 12-ft. marble wainscot, with plaster walls and ceilings. The smaller rooms will have plaster walls and ceilings and mosaic tile floors. The portion of the building through which the lobby runs has a second floor for offices. These all have outside light and open on a corridor encircling an inside light court above the lobby. A small basement room will contain the heating plant.

The main waiting room has a steel frame to carry the dome and attic roof. This presented something of a special problem in adapting it to the floor plan and to the form of superstructure. The frame is supported at four points only, these four steel columns being symmetrically placed at the four points indicated on the first-floor plan—the inner corners of the four small rooms in the corners of the waiting room. These points of support are well within the lines of the attic walls and the latter are carried by cantilever members and suitable girders, as shown in the sectional view of the main waiting room. Above the girders, and resting on them, are the steel roof trusses, of which there are six—three in each direction. These carry a concrete roof 6 in. thick, including a skim coat of 1 in., the concrete spans being arched between I-beam purlins, as shown.

There are four tracks, separated from the streets by ornamental iron fencing and protected by umbrella sheds 704 ft. long. These latter are the "butterfly" type, with roofs sloping upward from a central gutter, and quite similar in general design to those used at the new Washington terminal. A detail of the shed design is included in the illustrations. The cast-iron supporting columns are anchored to concrete blocks 7 ft. 6 in. x 5 ft. 6 in. in plan and 5 ft. 6 in. high, each resting on four piles. A track plan is also reproduced, showing the six curved approach tracks from the west, and the proposed freight terminal layout.

The cost of the station building and train sheds, exclusive of all track work and interlocking, will be $250,000. The plans were prepared, and the construction work done, under the direction of J. F. Hinckley, Chief Engineer of the Frisco system. The architects were D. H. Burnham & Co., Chicago, and Jas. Stewart & Co., St. Louis, Mo., are the contractors. F. L. Jonah is Terminal Engineer, in immediate charge of the work.

Reinforced Concrete Bridge Over the Sangamon River.

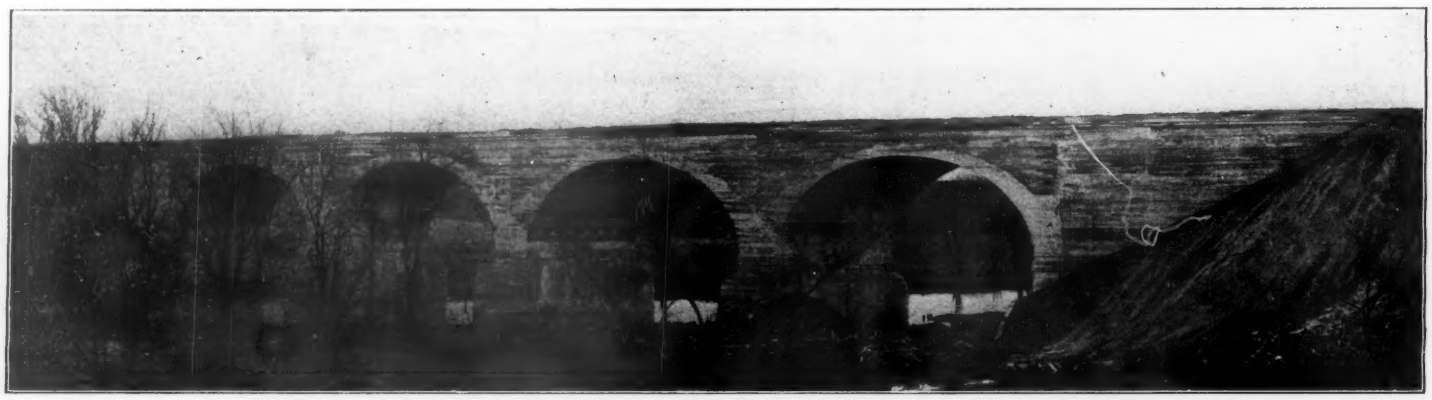
The Wabash line formerly crossed the Sangamon river valley, 3½ miles east of Decatur, Ill., on a single-track line with 1 per cent. grade and 4 deg. maximum curvature. Two years ago work was started revising the alinement and double-tracking the section from Decatur to Sangamon, six miles. This was completed in December, 1907. The new alinement has only two 1-deg. curves and the maximum gradient is 0.3 per cent. so that heavy construction was necessary.

The track was carried over the valley formerly by a steel bridge approached by sharp curves and heavy grades. This has been replaced by a double-track reinforced concrete bridge, drawings of which were published in the *Railroad Gazette* of December 21, 1906. The new line crosses the river at such an angle that the bridge is built on a skew of 45 deg. There are four spans, each 100 ft. center to center of piers. The clear opening, parallel to the tracks, at the springing line of the arch is 85 ft. 10 in., and at the bottom of the pier, 82 ft. 5¼ in.

The extrados of the arch is an arc of a circle, and the intrados is an ellipse. This ellipse is, in reality, the projection of a circle on a plane set at an angle of 45 deg. to the plane of the circle. Thus the form required for molding the concrete arch is cylindrical, its axis being at an angle of 45 deg. to the track and its radius being 30 ft. 4¼ in. at right angles to the line of the piers. This makes the false work construction quite simple.

The piers and abutments were so built with concrete skew-backs as to give square bearings for the arch ribs instead of skew bearings. This is shown in the accompanying drawings and is noticeable in the photograph, as it resulted in a saw-tooth effect at the springing line of the arch.

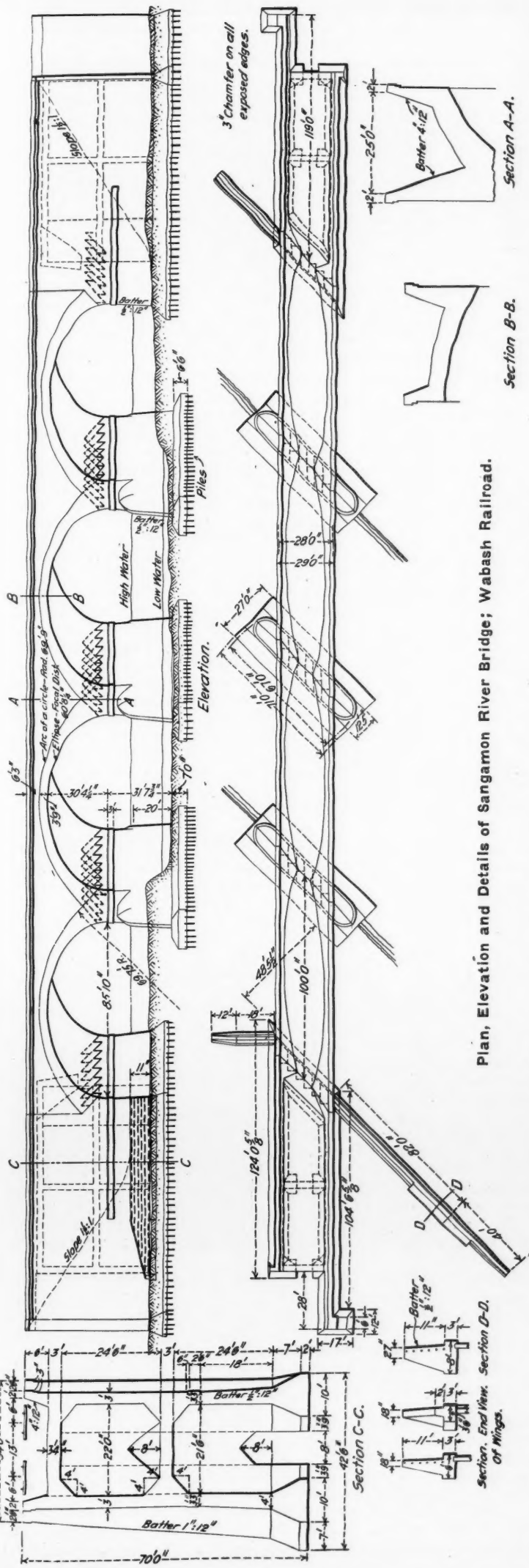
The foundation of the bridge rests on gravel, overlying a layer of very stiff clay. Piles were driven through the gravel into the clay and on them, for the pier foundations, were laid reinforced concrete slabs of such sizes as to distribute the load over a large area and also tend to prevent scouring. For each pier, 259 piles, spaced 3 ft. on centers, are used. Each abutment rests on 395 piles,



Reinforced Concrete Bridge over the Sangamon River; Wabash Railroad.

also spaced 3 ft. apart. Because of the height of the bridge the cost of ordinary abutments would have been excessive. The drawings show the abutments used. They are hollow, four chambers on two levels being formed; the rear lower chamber is filled with earth. The wing retaining walls are 10 ft. high (the height of maximum flood) and the fill rests against them. These prevent scouring of the toe of the high banks.

In erecting the bridge, concrete was built to the top of the skew-backs and allowed to harden. Then each arch ring was laid in one block by working night and day without stopping. The arch rings are heavily reinforced with 1-in. corrugated bars near the inner and outer faces. Throughout the structure, 1-in. rods furnished by the Expanded Metal & Corrugated Bar Company, St. Louis, were used. The abutment walls are reinforced with vertical ribs of three bars each, the ribs being spaced 2 ft. on centers; and with hori-



zontal four-bar ribs, 3 ft. centers. The arches are reinforced on both extrados and intrados with longitudinal five-bar ribs, 1 ft. on centers, and with two-bar ribs, from 2 ft. to 3 ft. on centers, parallel to the center line of piers. The reinforcement of the spandrel walls consists of horizontal two-bar ribs only, spaced 2 ft. on centers. Where the bars were spaced close together the concrete mixture was one part cement, 2½ sand and five gravel. The plain concrete and the concrete in which the bars were spaced 12 in. or more apart was a 1:3:6 mixture. There are vertical joints in the spandrel walls over the centers of the piers and at the skew-backs, to allow for deflection of the arch rings.

The bridge is designed to carry a dead load consisting of concrete at 150 lbs. per cubic foot and earth fill at 100 lbs. per cubic foot. The live load capacity is 9,000 lbs. per lineal foot of track for each track. The permissive unit stress was 600 lbs. to the square inch in the concrete and 12,000 lbs. for the rods. The permissive load on the piles was 25 tons per pile.

The building of the bridge required 8,320 cu. yds. of earth excavation and 36,775 lineal feet of piling. A total of 16,170 cu. yds. of concrete was used, as follows:

	Cu. yds.
Foundation slabs for piers	1,300
Piers proper, with skew-backs	2,270
Arch rings	2,370
Spandrel walls of arches	2,180
Foundations for abutments	1,580
Abutments above foundations, including slabs and intermediate walls, together with spandrel walls	5,930
Retaining walls	540

There were 215 tons of bars used and the cost of the whole bridge was slightly less than $124,000.

It was designed by A. O. Cunningham, Chief Engineer of the Wabash. The cement was made by the Wabash Portland Cement Company, Stroh, Ind., and the contractor for the work was the William P. Carmichael Company, Williamsport, Ind.; this company also designed the false work and forms.

The Capacity of the Interborough Subway.

On May 22 Bion J. Arnold presented to the New York City Public Service Commission the fourth of his reports dealing with the Interborough Rapid Transit subway. The last one of these reports, dealing with the signal system of the subway, was reviewed in the *Railroad Gazette* March 20; the general report on the operation of the subway was printed in the *Railroad Gazette* March 6, and the report on the cars was printed February 28.

In the report on the capacity of the subway, Mr. Arnold first calls attention to the fact that the previous reports dealt with minor changes which could easily be put into effect, such as improvements in the matters of despatching trains, changes in the signal system and the installation of additional side doors in the cars, some of which changes have already been adopted; but the present report analyzes the fundamental design of the subway, points out how further increase in its capacity can be obtained and directs attention to certain fundamental defects or omissions in the present subway which the author believes should be avoided in future subways. Mr. Arnold says that the spirit which prompts him in preparing these reports is to heartily commend the engineers who built the subway for the many excellent ideas embodied in this work and for the character of its construction, rather than to criticise them adversely for the few things which now seem to him advisable and which they did not do. He says also that it should be remembered that the pioneers in any field, acting without precedent to guide them, must overcome obstacles which are often lost sight of in subsequent criticism, and that it is always easier for those who follow these pioneers to point out what should have been done than it was to foresee them and to do them in advance. Mr. Arnold says that New York City has in its present subway the finest and most efficient example of underground railroad construction in the world; but this fact does not preclude the advisability of adoption of improvements if it can be shown that such improvements can be made, not only in the present subway, but in future subways.

An abstract of the report follows:

In considering an enterprise of this character it should be borne in mind that it should be the aim to establish and maintain a proper relationship between the fundamental elements entering into it, viz., safety, comfort, capacity, speed and a fair return on the investment.

In all of these elements, I find the present subway lacking. The absolute safety has been sacrificed to secure extra capacity, whereas even greater capacity than is now secured can be obtained by safe methods. The capacity of the subway decreases as the load, after it has reached a certain point, increases, which is exactly contrary to what should be expected. The speed of the trains is not maintained during rush hour periods just at a time when an advantage of speed would be of benefit not only to the greatest number of subway patrons, but also to the operators of the subway.

The comfort of the patrons is seriously interfered with by the arrangement of entrances and exits, both in the cars and in the

stations themselves. With the present type of subway car, the conflicting lines of passenger movement in and out of the cars actually subjects passengers at times to danger of personal injury during certain hours of the day. Finally, the returns on the investment are not sufficient to pay the necessary operating and maintenance expenses, interest at a reasonable rate on the investment, the sinking fund as required by the city, and at the same time allow a sufficient fund to be set aside to take care of depreciation.

A study of the present subway will reveal the fact that one of its fundamental defects, as far as its capacity is concerned, is that it fails to carry sufficient passengers upon a fixed five-cent fare to justify the large investment which was finally found necessary to produce this splendid means of transportation. The total investment required to build and equip the subway as it exists to-day amounts to approximately $75,000,000, of which $50,000,000 may be charged to the cost of the permanent way and $25,000,000 to the cost of equipment. Should it be contended that these figures include an excessive construction profit, it is but fair to state that it is quite probable, in fact almost certain, that were the subway to be constructed now, the open cut method of construction would not be allowed and thus the actual cost of reproducing the present subway would be increased by a greater amount than is represented by any amount which may be included in the above figures as a construction profit.

In 1907 the subway carried 182,000,000 passengers and during the present year it may possibly carry 200,000,000 passengers, resulting in an annual income of $10,000,000. Thus the gross income per annum from passenger traffic will be equal to only about 13 per cent. on the actual investment, as compared with surface and elevated railway systems, many of which take in an amount equivalent to 20 per cent. to 25 per cent. of the costs necessary to reproduce them.

For the last two years the operating expenses of the subway have amounted to an average of approximately 45 per cent. of the gross receipts. On this basis the annual operating expenses, with a gross income of $10,000,000, will amount to $4,500,000, leaving $5,500,000 to be applied toward the payment of interest, depreciation taxes, sinking fund and profit. This amount is only 7.33 per cent. upon the above investment of $75,000,000, and it is thus apparent that the present subway, which is now overloaded, is not built in such a way as to furnish sufficient capacity, with the conditions under which it has to operate, to produce financial results consistent with the investment.

Another serious defect of the present subway, under present operating conditions, is that it is capable of serving only about 50,000 passengers in one direction during each hour of the rush periods, and has no overload capacity. One high building in the business district will accommodate fully 10,000 people and high buildings are being erected much faster than subways can be financed and built. As the configuration of the island of Manhattan provides room for only a limited number of north and south subways, it is apparent that each route occupied should be utilized to its greatest practical capacity.

TRAIN CAPACITY.

The time schedule now in use calls for 30 trains per hour both on the express tracks and on the local tracks south of 96th street during rush hours. This schedule corresponds to a time interval between trains or headway of 2 minutes. In actual practice, on busy days, the headway at Grand Central station often reaches an average of 2 minutes and 10 seconds, which corresponds to a rate of 27.7 trains per hour.

It has been shown in my report upon the subway signal system that, with the present subway, it will eventually be possible to maintain a headway of 90 seconds, which will allow 40 trains to pass a given point in one hour, and that for future subways with suitably designed stations, it is not unreasonable to expect a capacity of 60 trains per hour over each track.

Upon the local tracks, which are not at present fully equipped with a block signal system, it is possible at the present time to operate on a headway of 72 seconds, thus providing for 50 trains per hour, but on account of the traffic being lighter on the local tracks and the difficulty of operating two schedules with different time intervals, for the local trains than for the express trains, and at the same time fitting in the trains in their proper order at 96th street, it has been and in my judgment will be found better practice to maintain the same headway upon both the local and the express tracks.

CAR CAPACITY.

Eight cars now constitute an express train and five cars a local train during the rush hours. The present maximum schedule of 30 trains per hour will thus provide 30 x 8 or 240 cars per hour on express tracks, and 30 x 5 or 150 cars per hour on the local service; a total of 390 cars per hour, and this may be taken as the limit of the car capacity of the subway under present operating conditions. On account of the delays due to heavy travel during the rush hours, this rate of car movement is not maintained throughout the entire rush-hour period.

The maximum capacity of the present subway under the best conditions practicable, without rebuilding all the express stations, will be shown to be 40 express trains per hour, of 10 cars each (400 cars) and 40 local trains per hour, of 7 cars each (280 cars), or a total of 680 cars per hour, as compared with the present schedule of 390 cars; in other words, it is possible to increase the capacity of the present subway up to a total car capacity per hour 75 per cent. greater than is attained at present.

SEATING CAPACITY.

Of the present cars, 800 are provided with 52 seats each, and the last 50 cars ordered, and recently put in service, are provided with 48 seats each. On a basis of a 2-minute headway upon both the local and the express tracks, the number of seats passing a given station can be taken at 370 cars with 52 seats each and 20 cars with 48 seats each, or 20,200 seats per hour.

It is possible to redesign the seating arrangement in the cars and to provide at least twice this seating capacity without adding to the number of cars operated, but for every additional seated passenger at least two standing passengers must be displaced. The present seating arrangements strike a fair balance between the two extremes of maximum seating capacity and maximum standing room.

PASSENGER CAPACITY.

During the rush hours the express trains carry an average of 125 passengers per car; that is, nearly twice as many passengers stand as are seated. Counts have been made showing as many as 180 people crowded into one car. If the 2-minute schedule could be maintained on the express tracks, the maximum carrying capacity under present conditions might be said to be 30 trains x 8 cars x 125 passengers per car, or 30,000 passengers per hour on one express track, and 30 trains x 5 cars x 125 passengers per car, or 18,750 passengers per hour, on one local track; a total of 48,750 passengers in one direction in one hour for both classes of service.

If 10-car express trains can be operated on a 90-second headway, each car carrying 125 passengers, then each express track should carry 40 trains x 10 cars x 125 passengers, or 50,000 passengers per hour in one direction, and this is the limit to the carrying capacity of each express track in the present subway. At the same time, if local trains of 7 cars could be operated on a 90-second headway, each local track should carry 40 trains x 7 cars x 125 passengers, or 35,000 passengers per hour in one direction. This would make a total carrying capacity through any one station, in one direction, of 85,000 passengers per hour, as compared with 48,750 passengers at the present time. In both cases the average loading of the cars has been taken at 125 passengers instead of at 150, as is frequently found at present on express cars.

HEADWAY.

The capacity of the subway is primarily a question of headway. Headway may be defined as the time interval between trains, it being understood that the time is taken at the instant the corresponding parts of each train pass a given point, i.e., the time elapsing between the instant the head end of one train moves by a signal until the head end of the following train moves by the same signal, or the headway may be easily determined by noting the time elapsing between the starting of one train from a station platform until the following train similarly starts.

This headway is influenced by two factors, which are independent of each other. The headway must therefore be determined in two different ways, and the operating, or actual headway, is found by taking the longest headway shown by either of the results. The two elements which influence the operating headway are the running headway and the station headway.

The safe time between trains running between stations which may be termed "running headway" is maintained by the block signal system. Under this arrangement, the time spacing of trains due to the running headway equals the time required to run three times the length of one block, plus the time required for two signals to clear, plus the time required for the train to run its full length at the maximum speed which it can run at this particular part of the road, plus the time required for the motorman to act after the distant signal has cleared from caution.

The time required for the train to clear a station block, which may be termed "station headway," is determined at present by the total time required by a train to enter the station block; to come to a stop; to open the doors; to unload; to load; to close the doors; to start, and to clear the platform.

The two headways are thus determined by entirely separate sets of conditions. A train in making a trip is influenced, first, by the "running headway," and then by the "station headway." The train, therefore, is constantly meeting varying conditions which influence the length of time which should elapse before the next train can follow. The minimum actual, or operating headway, is determined by the maximum length of time required to overcome these conditions at any limiting point throughout the entire trip.

As at present operated, these limiting points in the subway are now at the stations, that is, the station headway governs. The minimum running headway is considerably less than the minimum

station headway, so that trains can get up to certain express stations faster than they can get through these station blocks.

As already shown, the problem of increasing the capacity of the present subway resolves itself into a study of and the removal of the delay at the limiting points. The most serious delays at present occur at the following points:

a. At Grand Central station and other express stations.
b. Combined station and cross-overs at 96th street.
c. In addition to these critical points, there is a situation at South Ferry station which must be changed before the extension of the subway to Brooklyn can be used most effectively.

At the present time the delays at Grand Central station, which are typical of the delays at all other express stations, are due to a combination of causes, including confusion in the methods of handling the passengers, inflexibility in the signal system and defects in the car design. These disadvantages have been pointed out in detail in Reports Nos. 1, 2 and 3, in which it has been shown that the headway between trains, which now often reaches 2 minutes and 10 seconds (130 seconds), can be reduced to 90 seconds by means of the following improvements:

	Saving over present method.
1—Close the doors promptly and give signal for starting trains to motorman by an automatic train signal.....	10 seconds
2—Install a speed control signal system as an auxiliary to present signal system so as to allow the following train to reach the station platform more promptly than at present.....	15 seconds
3—Provide extra doors in the sides of the cars and guiding railings on the station platforms so as to avoid the present conflict of unloading and loading passengers and enable both operations to be carried on at the same time.....	15 seconds

These suggested improvements will make it possible to maintain at all times a train movement of 40 trains per hour upon the express tracks of the present subway, whereas as at present operated there are times during rush hours of every busy day when this rate falls to 27 trains per hour, due to the defects referred to above, all of which have been completely analyzed in the reports previously mentioned.

COMBINED STATION AND CROSS-OVERS AT 96TH STREET.

In addition to the regular combined local and express station platforms at 96th street, there are two cross-overs between the local and the express tracks just north of the station platform. These cross-overs are used by every Broadway express train and by every Lenox avenue local train, and therefore wherever one of the Broadway express trains and one of the Lenox avenue local trains going in the same direction approach the cross-over at approximately the same time, there must be a delay for one of the trains, which may amount to as much as 40 seconds, as one train must necessarily wait while the other uses the cross-over. During rush hours there is a Broadway express train scheduled to use the cross-over every 4 minutes in one direction and a Lenox avenue local scheduled to cross over to or from the local tracks in the same direction every 4 minutes, so that the opportunities for a conflict at these cross-overs are numerous. The delay in the train movement due to the cross-over acts exactly like the delay due to a prolonged station wait, and often has a cumulative effect upon the train schedule. The records show that the delays at 96th street are fully twice as serious as those at Grand Central station, due to the fact that at this station there are not only transfer platforms but also these cross-overs.

To remove the effect of the grade crossings, a rearrangement of tracks has been proposed by the engineers of the Public Service Commission. When the work, which has been authorized, or the suggested modification of it, is completed, the trains passing through 96th street can reach their respective tracks without making use of a grade crossing. When the same improvements in regulations, signal system and cars which have been suggested for improving conditions at Grand Central station and other express stations have also been put in effect at 96th street, and the tracks have been rearranged as described, then 96th street will cease to be a limiting point and the proposed 90-second headway can be maintained at this part of the system without difficulty.

THE SOUTH FERRY LOOP.

The two tracks which pass through the tunnels under the East river to form the Brooklyn extension to the subway, leave the express tracks at Bowling Green station. The two express tracks continue to South Ferry station, where they form a loop—both loop and station being directly over the point where the Brooklyn tracks pass into the tubes leading under the river. Since the subway has been opened to the Atlantic avenue station (May 1, 1908) the Lenox avenue express trains and the Dyckman street express trains run through the tunnel to Brooklyn, and the Broadway Kingsbridge express trains continue on around the loop at South Ferry. During rush hours, the Lenox express trains are scheduled for a headway of 3 minutes and the Dyckman express trains are scheduled for a headway of 8 minutes through the Brooklyn tubes; that is, for a short time each day the Brooklyn schedule calls for a headway of an average of 2 minutes and 10 seconds. The Kingsbridge express trains, which continue on around the South Ferry loop, run every 8 minutes during the busiest part of the rush periods. This service to Brooklyn will not be as satisfactory as the service on the rest of the line and as the facilities offered by the complete extension will attract a large patronage through the Brooklyn tubes, there will be a demand and need for running all the express trains directly through to Brooklyn. To meet this demand it will first be necessary to work out some plan for serving the South Ferry station, which accommodates a certain number of patrons using the ferries leaving Battery Park, for until some plan is devised and adopted for accommodating these patrons it will be impracticable to run all the express trains to Brooklyn.

There are three plans which should have consideration in connection with this problem—

1—A double-decked station at South Ferry. This plan would involve changing the present 3 per cent. grades of the tracks between the bulkhead of the tubes and Bowling Green station in order to provide an approximately level stretch of track at the stopping point or one upon which the grade does not exceed 0.5 of 1 per cent. in order that trains may remain at rest in case of failure of the brakes.
2—A shuttle-train service between South Ferry and Bowling Green station.
3—A moving platform either in the present subway between South Ferry and Bowling Green station or in an areaway just outside of the subway.

In my opinion it is advisable to install the shuttle train service first in order to give immediate relief, as this can be done at moderate expense, but when considering the subject in connection with future subways leading to the Battery, the other plans should receive careful attention.

INFLUENCE ON HEADWAY OF MORE EFFICIENT BRAKING.

A series of tests were made upon the rate of braking and these tests were compared to the results upon the Boston elevated electric road and upon other roads provided with improved braking equipments. These tests indicate that so far as efficiency is concerned the braking equipment of the subway cars is capable of producing results as effective as any that have been secured up to date with brakes acting upon the wheels. The tests showed, however, that these results were not always actually secured on account of the carelessness or timidity of the motormen. The tendency seems to be for a motorman to begin to apply his brakes too quickly—thus prolonging by perhaps four or five seconds the time that should be devoted to bringing the train to rest at the platform. At least five seconds can be taken from the headway by instructing the motormen to bring their trains up to the express station platform at a speed of at least 30 miles per hour, which will require that the trains be brought to a stop in from 16 to 17 seconds instead of the 20 to 22 seconds usually required. The fact that some of the motormen do this now shows that it can be done. There is no improvement which will show such effective results in proportion to the time and expense involved as will additional attention paid to this detail of operation.

Should it be determined to use platform railings as shown in Report No. 3 upon the "Subway Car," the saving of time which can be accomplished by this improvement in braking will more than offset the few seconds which may be required to accurately stop the trains.

INFLUENCE ON HEADWAY OF IMPROVED ACCELERATION.

It is but natural to expect and in fact it is contended by some, that considerable improvement could be made in the time required for accelerating the trains and that a number of seconds could be saved by moving the trains out of the stations more promptly.

As a matter of fact the actual acceleration tests show that in starting the trains and in moving them a distance equal to the length of the platform, there is but about two seconds difference between the best acceleration and the slowest acceleration observed. This would indicate that there is little improvement to be expected from training the motormen to be more skilful in using their controllers.

The tests indicate that the acceleration varies between 1.1 miles per hour per second and 1.4 miles per hour per second, and between these two figures fall all of the observations which have been made with varying loads and with different motormen.

The theoretical values of acceleration, which calculations based upon the motor curves indicate should be expected, fall between the values of 1.15 miles per hour per second for trains loaded with 150 passengers per car to 1.55 miles per hour per second for all cars empty and these theoretical figures agree very closely with the results of actual observation.

All eight-car express trains are provided with five motor cars each equipped with two 200 h.p. motors, and all five-car express trains have three motor cars similarly equipped.

Examination of other systems shows the following values of acceleration as the results of an average of a large number of observations:

Company.	Description of train.	Per hour, per second.
Metropolitan Elevated, Chicago	3-car train light, 2 motor cars	1.41 miles.
South Side Elevated, Chicago	5-car " " all motor cars.	1.35 "
South Side Elevated, Chicago	5-car " load'd, all motor cars	1.19 "
Metropolitan Elevated, Chicago	5-car " " 3 motor cars	1.06 "
Northwestern Elevated, Chicago	3-car " " 1 motor car	0.84 "

These tests and figures indicate that the motor equipment of the present subway is doing all that can be expected of it.

If all the cars of the subway trains were equipped with motors,

the initial acceleration in starting could be increased from 1.15 miles per hour per second to 1.65 miles per hour per second, with trains loaded with 150 passengers per car. This improvement in acceleration would cut down the time required for the train to leave the station platform by about two seconds, and this saving of two seconds is practically the limit of improvement which can be expected upon the headway by equipping all the cars with motors. It is apparent at once, therefore, that as far as the effect upon the capacity of the subway is concerned, the expense of increasing the present motor equipment would not be justified. The effect upon the speed of the trains of changes in the motor equipment will be discussed in a separate report.

Furthermore, if the signal system is re-arranged as recommended in Report No. 2 upon the signal system, the proceed signal will be given to the following train very soon after the leaving train starts to leave the platform and therefore the time required by the leaving train in accelerating will have no influence upon the cycle which determines the station headway.

A study of the comparative effect of improving the braking and acceleration of the trains indicates that more advantages can be expected from increasing the braking efficiency than can be anticipated from increasing the acceleration of the trains.

MORE CARS PER TRAIN.

In order to obtain the maximum practicable capacity of the present subway it will eventually be found desirable to increase the express trains from eight to ten cars, and the local trains from five to seven cars.

The easiest way to accomplish this change is to arrange to handle two more cars on each train, operating these cars on the ends of the trains, and not attempting to load or unload them directly from or to any platform south of 96th street.

These cars would soon become known to the regular patrons as through cars, and the guard in charge could discourage passengers who intended to stop at intermediate points from going into these cars.

It would be necessary to make a small number of changes in the block signal system in order to allow one of these lengthened trains to push a similar but disabled train to a terminal yard, an operation which is sometimes required, that is the block signal system must be slightly re-arranged, so that a double train of a total of 20 cars on the express tracks could be operated in case of accident.

Plans have been prepared to lengthen the platforms at 16 local stations south of 96th street from the present length of 200 ft. to 350 ft. each, so as to accommodate eight-car local trains. The estimates which have been prepared covering the cost of these changes run from $1,900,000 to $2,250,000. It is my opinion that the expenditure of this amount of money will not be justified at the present time. On account of the extensive use of the transfer privilege, the local trains are nearly always emptied of a load equivalent to their standing load at the present time at every express station stop, and the standing passengers, therefore, have an opportunity to find seats. Judging from present tendencies, the two through cars on each local train would prove attractive to a number of passengers who now use the express trains, and who would probably be glad to secure a seat on a local train running but a few minutes slower than the express in exchange for uncomfortable and crowded standing room upon an express train.

The increased car service on the local trains, should, therefore, tend to decrease the crowded condition of the express service. It would appear, therefore, that, if the added cars on the local trains can be devoted to through business, which originates and ends at or near their terminal stations, it will *not* be necessary to invest approximately $2,000,000 to provide an extension of the local platforms, which are now arranged to accommodate only five cars.

A similar line of reasoning will indicate that 10-car train service can be instituted on the express tracks without making a corresponding increase in the length of the platforms. To lengthen these express stations sufficiently to accommodate 10-car trains would also mean the extending of all station platforms north of 96th street. This would mean a large investment in order to do this work without interfering with the operation of the trains. In my judgment it is entirely feasible to operate 10-car trains on the express tracks and seven-car trains on the local tracks. A decided effort should be made to do this first without extending the platforms. If the difficulties attending this through-car service cannot be overcome in actual operation, then the platforms should eventually be extended.

WIDER CARS.

After the maximum practicable length of train has been reached and such trains operated at the rate of 40 trains per hour with the present subway, and through the use of double decked or reservoir stations at the rate of 60 trains per hour for future subways—there are apparently but two ways left for increasing the possible capacity of a subway without adding tracks and that is to widen the cars or to double deck them.

With the present subway, on account of the changes in stations, tracks, terminals and in the cars themselves the adoption of a higher or a wider car would be impracticable. For future subways the use of a wider car should be seriously considered but in my opinion greater advantages can be obtained by double decking the subways than by double decking the cars themselves.

In Report No. 3, "The Subway Car," I have discussed the proper design for a car at least 18 in. wider than the present car to be used in future subways, and as this wider car will add at least 25 per cent. to the possible carrying capacity without adding materially to the amount of the investment, it should be used unless reasons other than engineering and operating ones compel the adoption of cars having approximately the same width as those in the present subway.

MAXIMUM POSSIBLE CAPACITY OF SUBWAYS.

The minimum headway to be expected with the present subway upon tracks equipped with a block signal system is 90 seconds, corresponding to 40 trains per hour. It has been shown further that this limitation to the headway is due to the delay in the express station blocks. In future subways, this limitation to capacity should be eliminated by providing two station tracks at each express station to serve each main line track, so that one train at a station platform will not delay the following train, as is the case at present. In this way the tracks at the express stations would be arranged on the reservoir principle, so as to equalize and maintain at its maximum the rate of movement of the trains passing from one station to another. In other words, the stations which represent but a small portion of the cost of a subway system should be designed in such a manner that the great investment in the subway between the stations could be utilized to its fullest extent.

If the tracks between stations can be worked up to a capacity of 60 trains per hour (60-second headway) then the train capacity of future subways will be 100 per cent. greater than the capacity obtained under existing operating conditions in the present subway. If 10-car trains can be run every minute, a car capacity of 600 cars per hour can be secured with each track of a future subway. If each car carries 150 persons, the possible carrying capacity of a single track will be 75,000 passengers per hour or 150,000 passengers for two tracks whereas the possible capacity of two tracks in the present subway, as now operated, is less than 50,000 passengers per hour.

To determine the possibility of running 10-car trains on a 60-second headway, it is necessary to analyze the elements entering into the determination of the "running" headway of a train.

RUNNING HEADWAY OF TRAINS.

It is safe to operate 10-car trains every minute, even with the present type of signal system and brake equipment. This rate of train movement will be possible, however, only with railways where the stations are provided with two station tracks for each main line track, as the trains cannot operate on a 60-second headway if they are delayed in getting up to and through each station.

To increase the train capacity of the subway, improvements may be expected along the following lines:

(1) The present braking data upon which the signal system have been designed indicate a rate of deceleration or rate of braking of slightly less than two miles per hour per second. It is not improbable that tests made under subway conditions would show that an emergency stop at a rate somewhat in excess of this can be safely relied upon, provided the latest type of brake is used. A decrease in the length of the blocks of from 10 per cent. to 20 per cent. might be possible as a result of this revised information, and it is, therefore, important that a series of reliable tests showing the actual distance required to stop a loaded subway train by means of the automatic emergency trips be made before the block distances of future subways are decided upon.

(2) The signal system should allow the trains to run closer together than the minimum distance of three times the length of a block section, as is the case with the present subway. This can be done most effectively by arranging a series of caution signal lights, which will follow the movement of the preceding train more closely than the present caution signals which are now a full block distance apart. A traveling caution signal, if perfected, would allow the following train to encroach upon the overlap section of the block and approach nearer the danger signal, and thus safely reduce the minimum time interval between trains.

(3) Recent improvements in the signals themselves have been made by which the movable colored discs have been replaced by two sets of electric lights whereby the signal indications become practically instantaneous. In the figures from which the curves in the appendix have been prepared, a period of 2½ seconds was included to allow for these signal movements and the headways shown can therefore be reduced by this 2½ seconds in considering the absolute minimum headway possible for future subways.

These various improvements should make it possible to eventually maintain a 45-second "running" headway corresponding to a car capacity of 800 cars per hour with 10-car trains—but as it is impracticable to expect any system to be kept in operation for any great length of time up to its full ultimate capacity, I have based

my calculations for the capacity of future subways upon a practicable maximum capacity of 600 cars per hour for each express track, which would only require trains to run on a 60-second headway.

If it were practicable to rebuild and double deck all of the express stations of the present subway, there is no good reason why the above capacity of 60 trains per hour could not be secured, but the difficulties which would be encountered in changing the stations while keeping the road in operation combined with the expense of undermining the foundations of certain high buildings under which the subway runs, make this improvement now practically prohibitive, although the expense of this change may some time prove advisable in order to get capacity.

The maximum train capacity, therefore, of any properly signaled track of the present subway is 40 trains per hour as previously shown.

CARRYING CAPACITY OF A MOVING PLATFORM.

It is possible to install and operate a moving platform for the transportation of passengers under sub-surface conditions, and this method of solving the transit problem has been often advocated, but has never been put into practical every day operation for city transit. Such a platform would have a number of loading and unloading platforms moving at different speeds, usually varying in steps of three miles per hour. The platform carrying the seats can thus be made to move at either nine or twelve miles per hour, the latter speed being in excess of the average speed of a surface car.

A moving platform can be arranged to seat one passenger per lineal foot or 5,280 passengers for each mile of platform. If this platform moves at the rate of 12 miles per hour its carrying capacity will therefore be 62,500 passengers per hour and each of the patrons will have a seat. This capacity is more than twice the possible seating capacity of 10-car trains running on 60-second headway with 50 seats per car—but the platform only moves at the rate of 12 miles per hour, whereas the train can move its patrons at an average schedule speed of 25 miles per hour. In other words, the train method of operation has the advantage of having double the speed of the platform method and the platform method on the other hand has the advantage of having twice the seating capacity of the train method. The question is, do patrons of an underground system of transportation prefer speed or comfort; that is, would they prefer to patronize trains traveling at 25 miles per hour, but with only half enough seats to accommodate them in preference to a moving platform traveling at the rate of 12 miles per hour, but provided with seats for all?

It is probable that for short distance when speed is not an important element the moving platform with its "seat for every passenger" would be preferred, but that for comparatively long distance speed, even at a sacrifice of some capacity, is the result desired and there is therefore in my opinion no question as to the advantage of the train method of operation, for long haul subway conditions.

DESIGN OF STATION FOR FUTURE SUBWAYS TO SECURE MAXIMUM CAPACITY.

It has been shown that, with the present type of subway stations where the trains stop on the main line, the train capacity is limited to a 10-car train every 90 seconds or to 40 trains per hour, whereas if each station is provided with two station tracks for each main line track the trains could be handled at the rate of one every 60 seconds or 60 trains per hour. Therefore, the capacity of future subways can be materially increased by double tracking the stations, and this should be done at least on the express tracks at all express stations. Whether or not the local tracks should be double tracked depends entirely upon the use to which the local tracks are to be put. If, as in the present subway, these local tracks are to be used more as a collecting and distributing system for the express service than as a separate system of transportation, then there will be but little need of increasing the possible capacity of the local tracks above the capacity which will be provided by a single local track at each station. If, however, an effort is to be made, as it should be, to cultivate the short haul business by means of the local systems and at the same time encourage the use of the local trains for a certain amount of through travel, then arrangements should be made for double tracking the local as well as the express tracks at all transfer stations.

This arrangement of double tracks for the local service at the express stations would not necessarily mean double tracks for the local trains at intermediate local stations as the stops at these stations would not require over 15 seconds and this station wait would not materially affect the headway. At transfer stations, however, the local trains are liable to be held at the platforms as long as the express trains are held and therefore if there is a demand for frequent train service over the local tracks, these tracks should be provided with double tracks at the transfer stations, thus making each transfer station a double decked station with four tracks on each deck.

The question as to the best arrangement of the tracks in a station provided with double tracks for each main line track is an important one.

In the first place such a station must, as a rule, be "double decked"; that is, the express track platforms will be on a separate level (preferably a lower one) from the local track platforms.

In the next place, a decision must be reached as to whether or not separate platforms are to be provided for loading and for unloading the passengers. The policy of the extent of the transfer privilege from local to express service, and *vice versa*, must also be decided and, lastly, the question of how intimate a connection should be arranged between two intersecting subways must be settled.

CONCLUSIONS.

The facts brought out in this report upon the capacity of the subway may be briefly recapitulated as follows:

(1) The present subway, although carrying more passengers than it was originally designed to handle, lacks sufficient passenger carrying capacity under the conditions that it is now operating to pay a fair return on the investment and at the same time allow for a suitable depreciation reserve.

(2) The present subway is also defective in not having sufficient passenger carrying capacity to take care of the demands of transportation along its route during the two rush-hour periods of the day; that is, the subway is lacking in what might be termed overload capacity.

(3) The headway and therefore the capacity of the present subway is governed by the station headway; that is, the number of trains is limited by the number that can be passed through the limiting station. The capacity of future subways should be limited only by the number that can safely be passed over the tracks between stations.

(4) The present rate of train movement of 30 trains per hour in one direction upon each track can be increased to 40 trains per hour by

a—Installing automatic closing door signals upon the cars;

b—Providing speed control signals auxiliary to the present block signal system at the approaches to the stations;

c—Altering the cars to provide more doors in the sides of each car.

(5) To most effectively secure the benefit of these changes the cross-overs in the tracks north of 96th street station should be removed in accordance with the plans, which have already been approved by the Public Service Commission.

(6) The 96th street changes can be made still more effective by adding to these plans, the feature of double decking, thus providing two additional express tracks in the station.

(7) To secure the same capacity for the Brooklyn extension that will eventually be obtained for the Manhattan subway, a plan for handling the South Ferry passengers should be worked out so that all express trains can be run through the Brooklyn tubes, thus increasing their present capacity at least 33 per cent.

(8) The train capacity of the subway cannot be increased by increasing the speed of the trains as the increased length of the signal blocks necessary for the higher speeds more than offsets the advantage of the increased speed.

(9) The capacity of the subway can be increased by greater care in using the brakes at the stations. Very little effect upon the capacity can be expected by improving the acceleration of trains.

(10) Considerable improvement in the capacity can be secured by running longer trains and a movement in this direction should be started as it will eventually be found desirable to run seven-car local trains and 10-car express trains, both at the rate of 40 trains per hour. When this is done the capacity of the present subway will be increased 75 per cent. which is the maximum increase in capacity of the present subway that can be expected without double decking the stations which for reasons previously given seems to be prohibitive.

(11) While double deck cars in subways are impracticable, the possibility of using wider cars should be thoroughly considered in making plans for future subways, as there is apparently no difficulty in the way of using wider cars for such subways except the question of transferring the equipment between the present subway and future ones.

(12) To secure the maximum possible capacity of future subways, tests should be made to determine more accurately than has been done, the braking distance required to bring a subway train to rest from full speed when the emergency stop is used.

(13) An improvement in the block signal system which will have a material influence upon increasing the capacity of future subways can be secured by developing a traveling caution signal to act in conjunction with the present fixed one.

(14) Moving platforms have practically double the seating capacity of 10-car trains running upon 60-second headway, but on the other hand these moving platforms have a speed of only one-half the schedule speed of the train, and therefore the train method of operation is to be preferred for long distances.

(15) In order to secure maximum capacity for future subways these subways should be designed with double decked stations provided with double tracks for each main line and the cross section of the subway between stations should also where practicable be

double decked; this plan will allow the operation of 10-car trains on a 60-second headway on each track thus providing a carrying capacity of three times that of the present subway.

RECOMMENDATIONS.

The improvements suggested in this report may be summarized as follows:

(1) The changes required in the present subway to increase its capacity from 30 trains an hour to 40 trains an hour, with a marked increase in its earning capacity, should be carried out; that is, the block signal system should be improved, a speed control system developed, and the cars altered.

(2) The 96th street alterations should include not only the removal of the cross-overs as already approved by the commission, but also the altering of the station itself to provide a local track upon a lower level, allowing the four tracks upon the present level to be used by the express trains.

(3) A shuttle train service for the South Ferry station should be provided at once, and a comprehensive study should be made of a plan for a double-decked station at this point, which would not only give all South Ferry passengers a station on the main line, thus eliminating the shuttle train service, but also allow all trains to run through to Brooklyn.

(4) The braking of the trains at the station should be improved so as to save the 5 seconds which is now often lost by lack of skill in stopping the trains.

(5) One car should be added to the rear of each local train during rush hours, and the public should be encouraged to use this extra car upon the local trains, which, although not reaching the platforms, could be used for through travel, with the idea of adding even more cars to the trains if the public can be educated to take advantage of this increased accommodation.

(6) A series of braking tests showing the distance required to stop a train by means of the emergency stop from full speed should be made in order to secure reliable data for planning the block signal systems for future subways.

(7) The manufacturers of block signal systems should be encouraged to develop a traveling caution signal to supplement the present fixed caution signal, as this signal could be installed to advantage not only in the present subway but in future subways.

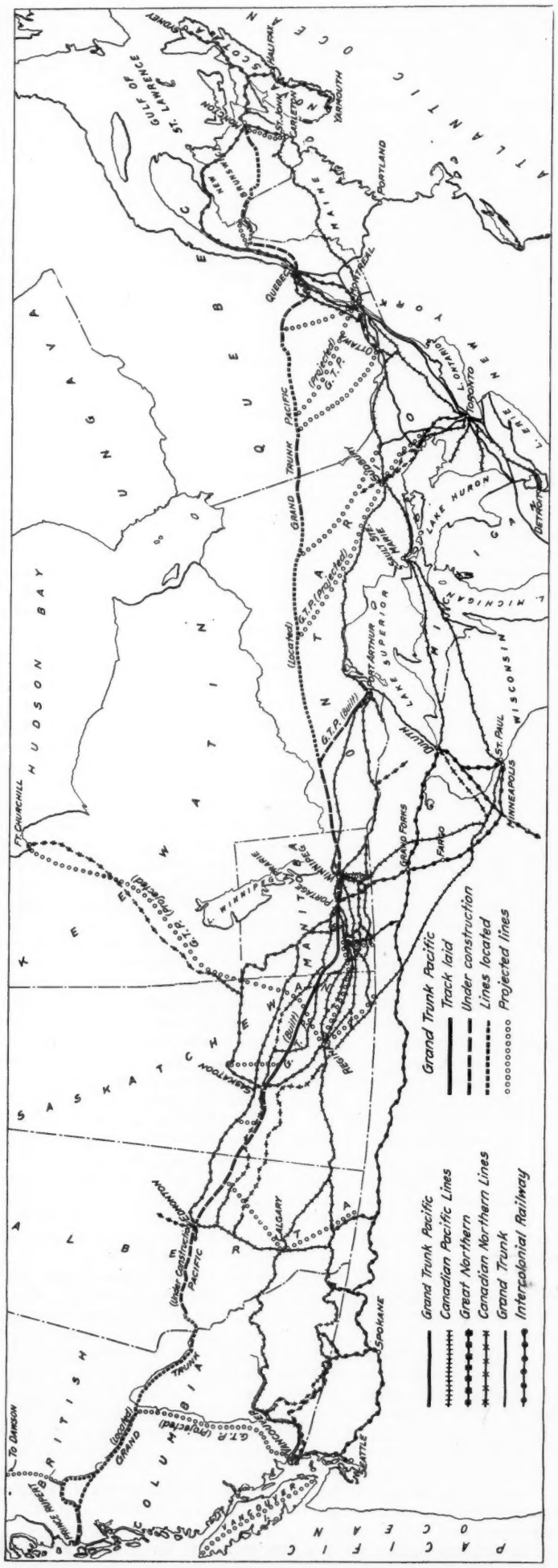
(8) If future subways are to be built and operated independently of the present one, the plans should be made with the idea of using multiple side door cars 18 in. wider than the present cars, thus adding at once 25 per cent. to the capacity of each car and increasing the possible carrying capacity of such subways without proportionately increasing their first cost.

(9) In order that future subways shall not only pay a fair return on their investment, but also allow for a satisfactory depreciation reserve, it is essential that such subways be located where there is sufficient density of traffic to justify their being built, and at the same time they should be so designed as to handle the volume of traffic which must be passed through them during rush hour periods in order to make them self-sustaining.

(10) All future trunk line subways should be designed with stations on the reservoir principle, that is, with double tracks in each station for each main line track. This can best be accomplished by not only double decking the stations, but also double decking the subways between stations, and by this method secure the carrying capacity necessary to justify the occupancy of the street, and at the same time produce a property which will justify its cost. Where a crosstown subway is to be provided for, the stations should be triple-decked.

The Grand Trunk Pacific.

The accompanying map shows the Grand Trunk Pacific lines completed, building and located, as well as the branch lines which are projected. The portion from Moncton, N. B., to Winnipeg, Man., 1,807 miles, is being built by the government under the name National Transcontinental. This is all located, except for a few miles near the Winnipeg terminals and possible revision at several other points. Contracts have been let for 656 miles from Moncton to Weymontachene, Que., and for separate sections between that point and Winnipeg aggregating 571 miles. The Lake Superior branch, running from Lake Superior Junction, Ont., southeast to Fort William, 210 miles, is being built by the Grand Trunk Pacific. On this branch grading except on eight miles has been finished and 125 miles of track has been laid. The Grand Trunk Pacific Branch Lines Co. has been authorized to build branch lines both east and west of Winnipeg. These are shown on the map as projected. The line from Winnipeg west to Prince Rupert, B. C., 1,750 miles, is being built by the Grand Trunk Pacific. This is all located. Grading is finished on the section from Winnipeg to Portage La Prairie, 56 miles, and track is laid from the latter point 500 miles to Earl, 75 miles west of Saskatoon, Sask. Work is under way from this point to Edmonton, Alb., 253 miles, and to a point 120 miles further west of Edmonton. From Prince Rupert eastward, work is under way on 100 miles of road to Kiteselas canyon, which is the junction between the direct line and the loop north of it. It is expected that the line from Winnipeg to Edmonton will be opened for traffic this year. Forces have been at work all through the winter from Winnipeg east to Lake Superior Junction, and it is estimated that during the summer about 30,000 men will be at work on the whole line from Moncton to Prince Rupert.



The Principal Canadian Railroads, Built and Building.

GENERAL NEWS SECTION

NOTES.

The New York legislature has passed a bill requiring railroad companies to pay their employees twice a month.

A press despatch from Bedford, Pa., says that the school of telegraphy maintained by the Pennsylvania Railroad at that place has graduated 60 students.

The Chicago & Alton now runs one of its trains through between Chicago and Kansas City in 13 hours, which is 30 minutes less than the previous time and 30 minutes less than the time made by any other line.

The five railroads running eastward from East St. Louis which absorb drayage charges on freight from St. Louis, will hereafter make the allowance on shipments brought by any one of 20 transfer companies, instead of only two companies, as heretofore.

Canadian papers report that the immigration into Canada this year has been smaller than last year by about 40,000 people, a result which is quite contrary to the expectations which were aroused by the heavy movement from Europe and the United States early in the spring.

A press despatch from Columbus, Ohio, says that the Brotherhood of Locomotive Engineers, now in convention in that city, has decided to admit to membership motormen on all those interurban electric railroads which operate 20 miles or more outside of an incorporated city.

The Canadian Pacific is to discontinue the 96-hour train which has been run between Quebec and Vancouver in connection with its ocean steamships. Under a new contract, the time allowed for carrying the mails from Liverpool to Hong Kong has been extended from 29½ days to 34 days.

At St. Paul, Minn., May 25, the United States Circuit Court of Appeals affirmed the conviction of the Chicago, St. Paul, Minneapolis & Omaha, and its General Freight Agent, H. M. Pearce, for having given illegal rebates on shipments of grain. The company was fined $20,000 and the agent $2,000.

The Chicago, Burlington & Quincy has announced a reduction of 25 cents a ton in the freight rates on coal carried from Wyoming and Colorado to points in Nebraska, west of Grand Island. This reduction is to meet one made by the Union Pacific in consequence of an order of the Interstate Commerce Commission.

The Black Diamond Express of the Lehigh Valley, between Buffalo and New York, which was taken off last winter, will be put back on its old schedule June 14. The train was taken off on February 9. It will leave Buffalo at 11 a.m., and New York at 12 o'clock daily, running through in 9 hours 55 minutes.

The Ohio legislature has passed a law under which the railroads of that state may, after July 7, collect from passengers paying fare on trains 10 cents more than from those who buy tickets at the offices. The law provides, however, that ticket offices at stations must be open 30 minutes before the departure of trains—which in thousands of instances will be 29 minutes more than is necessary.

A large part of Oklahoma and considerable territory in northern Texas were damaged by floods on May 23 and 24, about 20 inches of rain having fallen in 10 hours throughout a considerable part of this territory. At Dallas, Tex., a part of a bridge of the Texas & Pacific over the Trinity River was carried away by the flood and six men were drowned. Many railroad and wagon bridges were damaged in Oklahoma, and many miles of railroad suffered from washouts.

The Chicago, Burlington & Quincy will on May 31 begin running a fast limited train from Chicago, Omaha, Kansas City, St. Louis and other eastern points to the west over its Billings line, reducing the time to the Pacific coast 12 hours, arriving in Seattle in the morning instead of the evening as at present. An extra local train will be added for the accommodation of intermediate business. The train will leave all the eastern terminal points about as at present, but will cut the running time from 76 to 64 hours.

The New York, New Haven & Hartford announces that, beginning with June 10, it will make through freight rates from Connecticut points and from New York City to the west over the Boston & Maine and the Canadian Pacific (through Canada). Rates to Chicago and beyond by this route are 10 cents (first class) less than those by the direct routes, from points taking New York rates, and 5 cents (first class) less from Boston points. At present the Central Vermont, controlling the railroad from New London, Conn., northward to Montreal, and running steamers between New York and New London, is the only line which gives these low rates from places south of the Boston & Albany. Shipments by the new tariff will be sent through either Springfield or Worcester.

The gold medal offered by the *Scientific American* for the most meritorious invention in transportation, which has been competed for at the exhibition of the American Museum of Safety Devices, which has been held in New York City during the past month, has been awarded to the Rich Marine Fire Detecting & Extinguishing system, which is an apparatus for detecting fires in the holds of vessels. From a glass case on the bridge pipes, 1 in. in diameter, run to each hold and coal bunker and, by means of a small exhaust fan, kept constantly running, any smoke which might be formed in a given compartment would emerge from the corresponding pipe in the glass case, and thus warn the officer in charge, of the danger of fire. Every 15 minutes a bell rings, calling attention to the necessity of looking at the pipes. In case a fire is detected, hose can be attached to the pipe and by this means the endangered hold can be flooded with steam. It is said that this device has been installed on the Cunard steamers "Lusitania" and "Mauretania."

Governor Hughes, of New York, has vetoed the Robinson bill, which was designed to facilitate the construction of rapid transit railroads in New York City by allowing the city the privilege of selling franchises to corporations for 50 years, instead of for periods not exceeding 25 years, as is stipulated in the present law. Governor Hughes says that although the 50-year proviso is permissive, it would mean that all franchises would run for 50 years, for the city authorities could not be depended on to stand out for a shorter period; and the Governor believes that to surrender the rights of the city in its streets for so long a time as half a century is wrong. The exact financial status of the city, as regards its power to borrow money, should be authoritatively determined, and then if the legislature takes action which shall result in the adoption of an amendment to the constitution, the city may, within a year and a half, be able to build subways itself.

The proposal, embodied in a resolution by Senator Elkins, to suspend for a time the penalties which the Interstate Commerce Commission law imposes on railroads which carry their own commodities, was considered in the upper house of Congress last Friday; and, although no direct vote was taken, it is said that the subject has been laid aside finally for the present session. This leaves the penalties in full effect, so that an anthracite coal road, for instance, carrying to market coal from its own mines, is subjecting itself to severe penalties, the only assurance of immunity being the promise of the President and the Attorney-General to refrain from prosecuting any road for the collection of a penalty until the constitutionality of the law shall have been decided by the Supreme Court.

A press despatch from Washington, May 25, says that the Department of Justice has agreed with the coal carrying railroads that the case involving the constitutionality of the law shall be heard before three Federal judges in Philadelphia on June 16 next. The case is to be tried upon an agreed state of facts and no prosecutions are to be begun against the railroads directly interested in the suit until a decision of the court has been reached.

Another Low-Fare Veto from Governor Hughes.

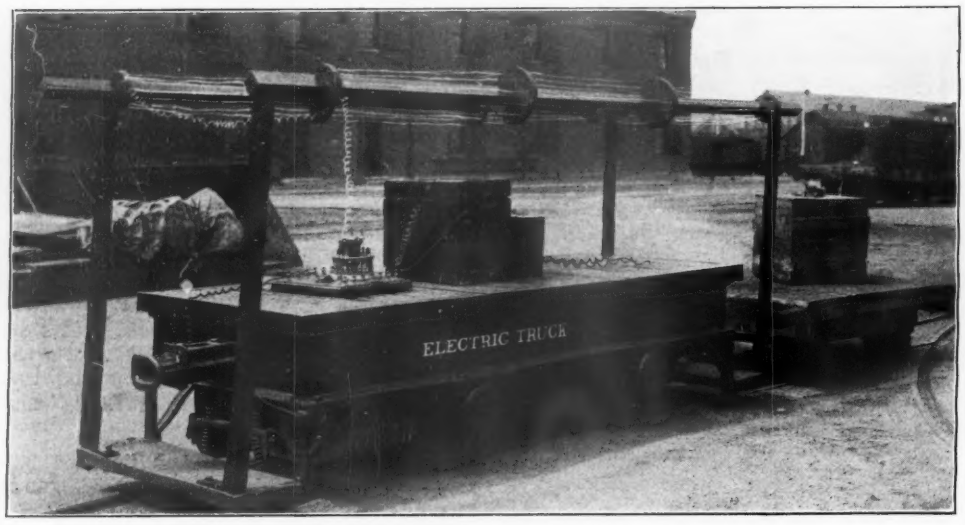
Governor Hughes of New York has vetoed a bill passed by the Legislature known as the Coney Island five-cent fare bill. His reasons are the same as those given a year ago in his veto of the general two-cent bill for the whole stage, the main point being that the legislature has acted without sufficient investigation. In the present case he says:

This bill establishes a maximum rate of five cents [on electric roads from Manhattan to Coney Island] without regard to the length of the route or the reasonableness of such a fare. In other words, it is an arbitrary maximum imposed by legislative fiat. But it is clear that if the rate is not a reasonable one and if the requirement would operate as a confiscation of the company's property the legislature cannot impose it. The attempt to enforce such a rate under such circumstances would be abortive, as a successful appeal could be made to the courts. It is idle to suppose that the companies can be compelled to reduce their fare to five cents merely because the legislature says so.

Whether a five-cent fare is a fair one depends upon facts and not upon sentiment, desire or prejudice; whether the result be agreeable or disagreeable it inevitably will be reached only after

the facts have been ascertained and considered. Justice requires this and under the Constitution the requirement will be enforced. The proper way to deal with these matters is to provide for investigation in which the whole subject can be considered, specious claims sifted out, and a result just both to the corporations and to the public arrived at.

It is highly important that we should have transportation in our cities at the lowest fair rates. It is desirable that in New York City there should be low rates from the congested quarters to the breathing spots in the outlying districts and by the sea. The sure way and the only way to make real progress in this direction is through the ascertainment of the essential facts and the making of reasonable rates in accordance with the facts. This bill is wrong in principle and is not adapted to secure the desired result.



Wireless Controlled Electric Truck; Union Pacific.

W. C. Brown on Rate Increases.

I regard the present question as one of the most important that has ever engaged the attention of the business interests of the country. I firmly believe that upon its righteous solution depends the momentous question of an early return to prosperity, or a continuance of the depression of the past six months, emphasized and darkened by a struggle with organized labor such as this country has never experienced.

The issue is in the hands of the business men of the country. If the business interests of the nation shall, after mature consideration, say that railroad rates shall not be advanced, I doubt if it can be done. But it should be understood clearly, definitely and beyond all question of doubt, that in saying this they say just as clearly and definitely that the wages of the great army of 1,500,000 railroad employees shall be reduced, and they must accept their full measure of responsibility for the results which will follow.

A Lackawanna Circular to Employees.

"The principle that underlies courteous treatment of others is simply that of doing unto others as you would they should do unto you.

"In a highly complex and technical business such as that of the railroad, there are many things that you, with your training and daily experience, understand with perfect familiarity, but which the public do not understand; therefore, do not assume that the public should comprehend them without asking questions, but when they make inquiry of you give them the courtesy of a reply just as full and clear as you can make it, without any suggestion of superiority born of a greater knowledge.

"Words are only one means of expression, and manner is quite as important; therefore remember that a kindly and gracious manner is not only the sign and mark of a self-respecting man, but is to your words what oil is to machinery in making them move effectively to their purpose.

"True courtesy is no respector of persons. It gives the civil word and the helping hand quite as readily to the ill-clad stranger as to an official of the company.

"Courtesy is not only something the public have a right to expect of you, but it pays. It pays in the friends it makes you personally and as a representative of the company. It pays in minimizing the friction of your life, as well as that between the company and its patrons. It pays in raising your standing with the company.

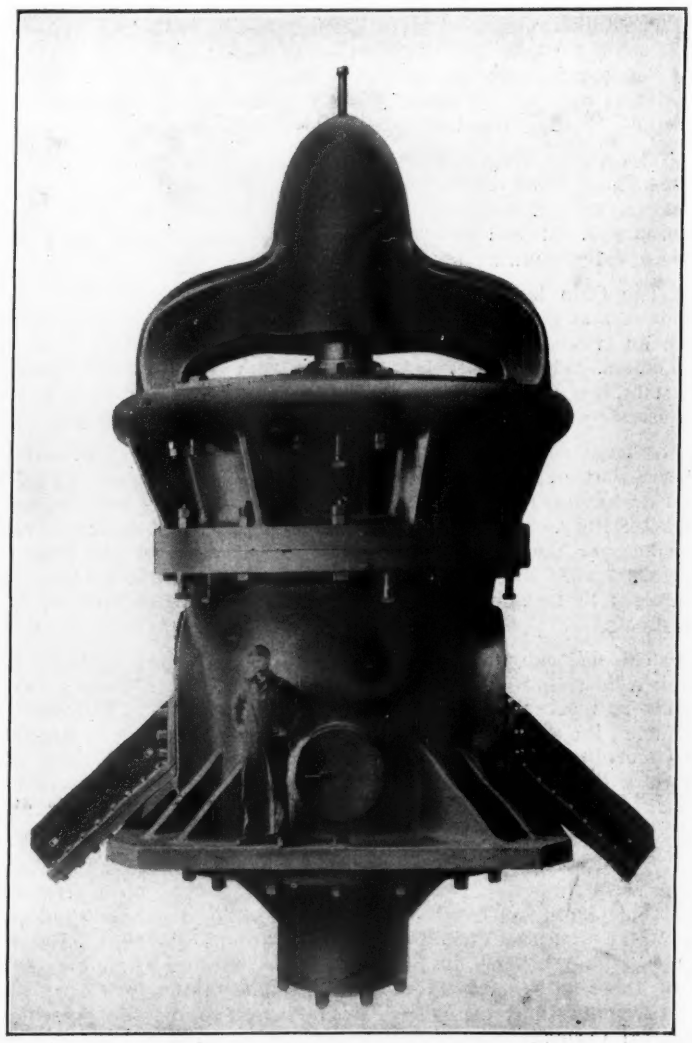
"It is the wish of the management of this company that all its representatives, whose work brings them into contact with the public, may appreciate and fully measure up to their duty and privilege in this respect."

Wireless Control of Shop Truck.

Frederick H. Millener, electrician, has for several months been working under the direction of W. R. McKeen, Jr., Superintendent of Motive Power and Machinery of the Union Pacific Railroad, on a system of wireless or remote control of a truck running on the industrial tracks of the Union Pacific shops at Omaha, Neb. The illustration shows an electric truck made by the Westinghouse Electric & Manufacturing Company, weighing about 5,500 lbs., which is driven by an electric motor supplied by a storage battery. The truck is capable of hauling a load of 10 tons at a speed of six miles an hour. It carries 144 ft. of copper wire made into a wireless wing and an antenna about 2 ft. high, by which the electric waves are picked up and transmitted to controlling devices beneath the frame. The experiments have progressed so far that it is now possible, by the use of the device, to move forward, reverse, stop, or to move at any desired speed by means of the specially shaped antenna and traveling ground communication. Similar antennae built like a cylinder and attuned to the car apparatus swing from a flag pole 65 ft. above the central controlling station. From these are sent waves that control the movement of the truck.

A Large Rock Crusher.

The Allis-Chalmers Co. has recently completed at its Reliance Works in Milwaukee, Wis., the No. 18 Gates, 600 to 800-ton capacity rock crusher shown in the accompanying cut. The machine weighs 200 tons and will reduce, to sizes suitable for railroad grouting and foundation work, rocks weighing three tons. It is said to be the largest rock crushing machine ever built.



No. 18 Gates Rock Crusher.

Disastrous Collision in Belgium.

Press despatches of May 21 report a rear collision of passenger trains at Contich, Belgium, at 8 o'clock on the morning of that day in which 50 or more persons were killed and over 100 injured. Nearly all of the killed were passengers in the three rear cars of a local passenger train carrying excursionists which, while standing on a side track, was struck by an express train running at full speed. The engineman and fireman of the express were killed. Several of the cars in the express train were badly broken, so that a number of passengers in this as well as in the local train, were injured. Contich is six miles southeast of Antwerp on the main line from Antwerp to Brussels. The reports give contradictory accounts of the cause of the accident, but at the present writing it looks as though it was the loosening by a repairman of a switch which was undergoing repairs. According to one account, the express train was derailed at this switch and its engine fell against the cars of the standing train after it had run off the rails.

New Traffic Order.

An executive order has been issued by the Interstate Commerce Commission as follows: "Under the decision of the commission in the case of *'Cosmopolitan Shipping Co. v. Hamburg-American Packet Co. et al.,'* and under rule 86 of tariff circular 15-A, carriers engaging in export and import traffic between points in the United States, and points in foreign countries not adjacent are required to publish their rates and fares to the ports and from the ports; and if as a matter of convenience to the public they publish in their tariffs through export and import rates or fares to or from foreign points in connection with ocean carriers such tariffs must distinctly state the inland rate of fare.

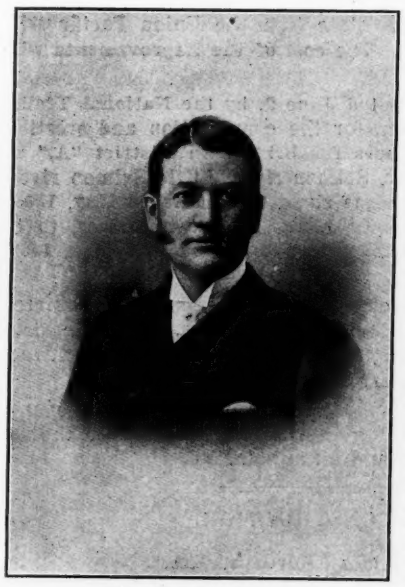
"Extensions of time have been granted to some carriers giving them until July 1, 1908, to comply with the requirements of said rule. It is now

"Ordered that all carriers subject to the act to regulate commerce shall comply with the requirements of rule 86, tariff circular 15-A, on or before July 1, 1908, by filing with the commission tariffs constructed in accordance with the rule and by canceling tariffs that do not conform to the requirements of this rule, and which contain rates or fares upon traffic exported to or imported from a foreign country not adjacent to the United States."

MANUFACTURING AND BUSINESS.

The Alexander Milburn Co., Baltimore, Md., recently received an order for a number of 5,000 c.p. acetylene lights for use on the Panama Canal.

William D. Ewart, the first president of the Link-Belt Co., Philadelphia, Pa., died at Rome, Italy, on May 3. Mr. Ewart was 56 years old. He invented the malleable iron detachable drive chain which was first known under his name. The Ewart Manufacturing Co. manufactured this chain, which is now called the link-belt, for many years, the product being handled by the Link-Belt Machinery Co., and the Link-Belt Engineering Co. In 1906 all three were consolidated into the present company, in which Mr. Ewart had a large interest and which is still being largely managed by his former associates. He combined inventive ability with executive capacity, being noticeably successful in harmonizing differences and getting co-operation. He retired on account of poor health and went abroad in the hope of recovery.



William D. Ewart.

Borlido Moniz & Co., P. O. Box 262, Rio de Janeiro, Brazil, wish to act as general commission agents for handling railroad equipment and supplies, electric machinery, builders' supplies, etc., in Brazil, and are asking for catalogues and correspondence from American firms.

The Glacier Metal Co., Richmond, Va., which is building a new plant at Manchester, Va., is now in the market for furnaces for the manufacture of babbitt metal, brass, etc., and also wants information on reclaiming metal from drosses and extracting tin from old cans.

The Maryland Railway & Electric Supply Co., Baltimore, Md., has opened branches at 1629 Candler building, Atlanta, Ga., and 312 Tyler building, Louisville, Ky.

F. P. Huntley, Vice-President and General Manager of the Gould Coupler Co., New York, has just returned from a several months' business and pleasure trip abroad.

Samuel E. Duff, formerly Manager of the Allegheny works of the Riter-Conley Manufacturing Co., Pittsburgh, Pa., has opened an office as Consulting Engineer in the Empire building, Pittsburgh, Pa. His specialties will be the designing of bridges, buildings, manufacturing plants, and special tools for steel work, while he will also develop his continuous steel railroad track support.

Fairbanks, Morse & Co., Chicago, Ill., have moved to their new offices at the corner of Wabash avenue and Eldredge place. The building, which is 165 ft. x 40 ft., is a seven story structure and contains the offices of all departments of the company, including the administrative, domestic and foreign sales, construction, purchasing, railroad departments, etc. The new warehouse of the company at Nineteenth and Sangamon streets is a five-story brick building, 100 ft. x 100 ft. The company's branch houses at Denver, Colo., Omaha, Neb., and San Francisco, Cal., have also moved into new buildings, and the Los Angeles, Cal., branch will do so within a few months.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad conventions and engineering societies, etc., see advertising page 24.)

Transportation and Car Accounting Officers.

The Association of Transportation and Car Accounting Officers will hold its summer meeting at the Clifton Hotel, Niagara Falls, Ont., June 23 and 24. Reports will be received from the Committees on Car Service and Per Diem, on Office Methods and Accounting, on Handling Railroad Business Mail, on Conducting Freight Transportation, and on Conducting Passenger Transportation. There will be the regular election of officers.

American Association of General Baggage Agents.

The twenty-seventh annual convention of this Association is to be held at the Hotel Plankinton, Milwaukee, Wis., June 17. At this meeting the discussions will include the following subjects: Limited Liability on Baggage; Settlement of Line Claims; Division of Excess Baggage Earnings; Uniform Excess Baggage Rates; Interline Charge for Dogs; Borrowing of Tickets for Checking Excess Baggage; Showing Junction Points on C.O.D. Checks; New Form of Baggage Checks to Prevent Mis-Matches; Should Lead Pencil be Used in Making Out Baggage Checks?

American Society for Testing Materials.

This society, affiliated with the International Association for Testing Materials, will hold its eleventh annual meeting at Atlantic City, N. J., June 23-27. The headquarters will be at the Hotel Traymore. The programme includes reports as follows:

Testing is not Inspection. W. A. Aiken.
Standard Specifications for Cast-Iron and Finished Castings. Walter Wood, Chairman.
Method of Obtaining a Truly Circular and Uniform Chill in Rolls. T. D. West.
Standard Tests for Road Materials. L. W. Page, Chairman.
The Acceptance of Stone for Use on Roads Based on Standard Tests. R. S. Greenman.
Fuel Investigations, Geological Survey; Progress During the Year. J. A. Holmes.
The Structural Timbers of the Pacific Coast. R. Thelen.
Address by the President on Some Features of the Present Rail Question.
Relative Corrosion of Steel and Wrought Iron Water Pipes. H. M. Howe.
Corrosion of Iron and Steel. A. S. Cushman, Chairman.
Electrolysis and Corrosion. A. S. Cushman.
Results of Endurance Tests on Wrought Iron, Steel and Alloys. Henry Souther.
Results of Tests of Steel Columns in Progress at Watertown Arsenal. J. E. Howard.
Heat Treatment of Iron and Steel. H. M. Howe, Chairman.
Practical Applications of Metallography. William Campbell.
Tempering and Testing of Steel Springs and Standard Specifications for Spring Steel. J. A. Kinkead, Chairman.
Tests of Stayboits. E. L. Hancock.
Standard Specifications for Paving and Building Brick. L. W. Page, Chairman.
Influence of the Absorptive Capacity of Bricks Upon the Adhesion of Mortar.
Standard Specifications for Iron and Steel Rails. W. R. Webster, Chairman.
Results of Work on the Metallurgy of Steel in Progress at Watertown Arsenal. J. E. Howard.
Microscopic Investigation of Broken Rails; Manganese Sulphide as a Source of Danger. Henry Fay.
Results Showing the Behavior of Rails under the Drop Test, and Proposed New Form of Standard Drop Testing Machine. S. S. Martin.
Failures in the Base of Cold-Rolled Rails. P. H. Dudley.
Rail Failures—Split Heads. M. H. Wickhorst.

Notes on the Rail Situation. E. F. Kenney.
Standard Specifications for Cement. G. F. Swain, Chairman.
Portland Cement Standards, Especially for Tensile Strength. W. W. Maclay.
Reinforced Concrete. F. E. Turneaure, Chairman.
Sands—Their Relation to Mortar and Concrete. H. S. Spackman and R. W. Lesley.
Permeability Tests of Concrete with the Addition of Hydrated Lime. S. E. Thompson.
Tests of Reinforced Concrete Beams Under Oft-Repeated Loading. H. C. Berry.
Cement Analysis. S. F. Peckham.
Formulas for Reinforced Concrete Beams in the Light of Experimental Data. W. F. Scott.
Fireproof Qualities of Concrete. R. F. Tucker.
Shearing Values of Stone and Concrete. H. H. Quimby.
Methods and Records Used in the Laboratory for Testing Cement and other Materials for the Subway and Elevated Railway in Philadelphia. S. A. Brown.
Influence of Fine Grinding on the Physical Properties of Portland Cement. R. K. Meade.
Tests of Bond in Reinforced Concrete Beams. M. O. Withey.
Cement and Concrete Work of U. S. Reclamation Service, with Notes on Disintegration of Concrete by Action of Alkali Water. J. Y. Jewett.
Preservative Coatings. S. S. Voorhees, Chairman.
General Discussion "Will 'Pure-Paint' Legislation Give Us Better Paints?"
Solubility Tests on Protective Coatings. G. W. Thompson.
Analysis of Varnishes. P. C. McIlhiney.
Standard Tests for Lubricants. A. H. Gill, Chairman.
Use of the Extensometer in Commercial Work. T. D. Lynch.
Features of a 600,000-lb. Universal Testing Machine. T. Y. Olsen.
Pendulum Testing Machines. T. Y. Olsen.
Automatic Recorder for Commercial Tension Tests. H. F. Moore.
Magnetic Testing of Iron and Steel. J. W. Esterline, Chairman.
Uniformity in Magnetic Testing and in the Specifications of Magnetic Properties. C. W. Burrows.
Uniform Specifications for Boilers. E. D. Meier, Chairman.
Forest Service Tests to Determine the Influence of Different Methods and Rates of Loading on the Strength and Stiffness of Timber. (*a*) The Purpose and Scope of the Investigations. McGarvey Cline. (*b*) Analytical Discussion of Speed-Strength Relation. H. D. Tieman.
Manganese Bronze. C. R. Spare.
Standard Specifications for Hard-Drawn Copper Wire. J. A. Capp and W. H. Bassett.
Structural Materials Testing Laboratories, U. S. Geological Survey. R. L. Humphrey.
Combined Stresses on the Elastic Properties of Steel. E. L. Hancock.
Fireproofing Materials. I. H. Woolson, Chairman.
Waterproofing Materials. W. A. Aiken, Chairman.

At this meeting there will be an election of officers, and the official ballot is as follows: For President, Charles B. Dudley; Vice-President, Robert W. Lesley; Secretary-Treasurer, Edgar Marburg; Member of Executive Committee, James Christie.

Special rates on the American plan at the Hotel Traymore have been secured for members of the society and their guests.

ELECTIONS AND APPOINTMENTS.

Executive, Financial and Legal Officers.

Alaska Central.—John F. Goodwin has been appointed Receiver of the Alaska Central and the Tanana Railway Construction Co.

Canadian Pacific.—Joseph Dunsmuir, Lieutenant-Governor of British Columbia, has been elected a Director, succeeding Clarence Mackay.

Chesapeake & Western.—W. E. D. Stokes has been elected President, succeeding Robert McM. Gillespie, resigned, and A. H. Gleason has been elected Vice-President, succeeding J. J. Vatable, resigned.

Operating Officers.

Missouri Pacific.—L. B. McGuire, Trainmaster at Nevada, Mo., has assumed also the jurisdiction over the Rich Hill branch, Fort Scott branch, Asbury branch and Pittsburgh district of the Joplin division. D. H. Robinson, transferred, formerly had jurisdiction over these branches.

Traffic Officers.

Buffalo, Rochester & Pittsburgh.—H. E. Huntington, General Agent of the Erie at Buffalo, N. Y., has been appointed General Passenger and Baggage Agent of the Buffalo, Rochester & Pittsburgh, with office at Rochester, N. Y., succeeding E. C. Lapey, effective June 1.

Chicago, Rock Island & Pacific.—H. H. Embry, General Freight Agent west of the Missouri river, with office at Kansas City, Mo., is to be retired on account of retrenchments, his office abolished and his duties to be assumed by G. B. Albright, Assistant General Freight Agent, with office at Kansas City, Mo., effective June 15.

Lake Erie & Western.—L. B. Sweet, General Freight Agent, with office at Indianapolis, Ind., has resigned, effective June 15, and will be succeeded by M. D. Maxwell, now Assistant General Freight Agent at Indianapolis.

San Pedro, Los Angeles & Salt Lake.—William Bogart has been appointed General Agent at Pittsburgh, Pa., succeeding H. S. Drysdale, resigned.

Engineering and Rolling Stock Officers.

Mexican Central.—W. Byrd Page has been appointed Assistant Superintendent of Machinery, with office at Aguascalientes, Aguas., succeeding C. H. Burke, resigned.

LOCOMOTIVE BUILDING.

The American Railroad of Porto Rico has ordered two compound consolidation locomotives, cylinders 14 in. and 20 in. x 20 in., from the American Locomotive Co.

CAR BUILDING.

The American Dressed Beef & Packing Co., Kansas City, Mo., has ordered 50 refrigerator cars from the American Car & Foundry Co.

The Delaware, Lackawanna & Western, which has been figuring on 26 passenger cars and 300 forty-ton steel hopper coal cars, has postponed the purchase for the present.

RAILROAD STRUCTURES.

Beaver, Pa.—Contract is reported let by the Pittsburgh & Lake Erie for the steel, also the construction of its proposed bridge over the Ohio river at this place, to the McClintic-Marshall Construction Co., of Pittsburgh, at $1,000,000. (Oct. 25, p. 508.)

Bloomington, Ill.—The Chicago & Alton is rebuilding a part of its machine shops and offices, recently damaged by fire.

Chicago, Ill.—The Chicago & North-Western, it is said, has bought 30,000 sq. ft. on the river front near Fifteenth street in the southern district of Chicago, on which, it is said, a dock 750 ft. long will be built.

The proposed 15 bridges over the drainage canal with operating machinery to cost $1,000,000 to be put in within 18 months, include seven railroad bridges over the main channel of the canal, and eight public bridges.

Childress, Texas.—The shops of the Fort Worth & Denver City, recently damaged by fire at a loss of $200,000, are to be rebuilt.

Denver, Colo.—The Colorado & Southern, it is said, is planning to build many bridges in Colorado.

Hillsboro, Texas.—The Trinity & Brazos Valley, it is said, will put up a bridge and viaduct here to cost about $16,000.

Mt. Sterling, Ky.—The State Railroad Commission has ordered the Chesapeake & Ohio to replace the present station with a new structure.

New York, N. Y.—The New York Central & Hudson River has filed plans for the east section of its new station at Forty-second street. It is to have a frontage of 366 ft. on Depew place and a depth of 72 ft. The building is to be seven stories high with two underground floors to be used by trains.

North Platte, Neb.—Local reports say that considerable improvements are to be made by the Union Pacific here to include large yards, new roundhouses, coal docks and car repair shops. The work is to be finished this fall.

Omaha, Neb.—Local reports state that the Union Pacific will resume work on its shops here. The cost of the improvements will be about $1,000,000.

Ottawa, Ont.—Bids are wanted June 9, by the National Transcontinental Railway Commission, for the construction and erection of steel superstructures and floors for bridges in District "A," as follows: Over the Canaan river, Salmon river, Little Salmon river, Four Mile brook, Grand river, Sigas river, to be finished May, 1909; Quisbia river, Green river, Iroquis river, Madawaska river, to be finished October, 1908, and Baker brook, to be finished May, 1909. P. E. Ryan, Secretary.

Spirit Lake, Idaho.—An officer of the Idaho & Washington Northern writes that work is to be started June 1 putting up shops and a roundhouse to cost, with the machinery, $250,000. Contract let to Westinghouse, Church, Kerr & Co., of New York.

Superior, Wis.—The Wisconsin & Minnesota Bridge Company, recently incorporated, is planning to build a bridge over the St. Louis river between Wisconsin and Minnesota.

RAILROAD CONSTRUCTION.

New Incorporations, Surveys, Etc.

Ajo Valley Railroad.—An officer writes that this company proposes to build a line from Theba, Ariz., where connection is to be made with the Southern Pacific, south to the Ajo mines, and thence to the Mexican border, about 125 miles. Surveys are made but contracts are not yet let. Plans are being pushed for financing the project, also for building the line, and it is expected that work will be started shortly. Michael Meehan, President, 10 Tremont street, Boston, Mass., and F. A. Bordwell, Chief Engineer, Tucson, Ariz.

Albany & Schoharie.—The bill extending the time for the construction of this line, projected since 1895, has been vetoed by the Governor of New York.

ALEXANDER & EASTERN.—Organized with a capital of $100,000, and office at 806 W. Pike street, Clarksburg, W. Va. The company proposes to build a line from Alexander, W. Va., northeast to Elkins, about 30 miles. J. B. Hart is interested.

ALEXANDRIA, LEESVILLE & LUFKIN.—Organized in Louisiana to build a line from Lufkin, Texas, east to Alexandria, La., about 140 miles. M. O'Brien, President; T. T. Wingate, J. J. Hicks and W. K. Ferguson are Vice-Presidents; C. W. Schwitzer, Secretary; J. E. Duff, Treasurer; D. M. Schollars, Attorney at Leesville, La., and H. H. White, Attorney at Alexandria.

BITTER ROOT.—Organized to build a line from Lewiston, Idaho, east to Butte, Mont., about 350 miles. Surveys made from Lewiston to Clearwater river, 85 miles, but construction work has been indefinitely postponed. C. G. Sutherland, President; G. W. Boschke, Chief Engineer.

CHICAGO, ROCK ISLAND & PACIFIC.—The first 20 miles of this company's proposed connecting line projected from Amarillo, Texas, west to Tucumcari, N. Mex., 110 miles, has been put in operation. (March 27, p. 461.)

COLORADO, TEXAS & MEXICO.—At the annual meeting of this company, President Morris K. Locke, of Abilene, Texas, reported that 79 miles of grading had been finished. Negotiations are pending for 100 miles of track material for immediate use on the line between Mangum, Okla., and Chillicothe, and on the Hollis branch. The line is projected south to Abilene, Texas. (April 17, p. 559.)

COTTON BELT.—Organized in Georgia to build a railroad from Louisville, Ga., northeast via Vidette and Wainsboro, to a point near Shell Bluff landing on the Savannah river, about 50 miles. Frank R. Durden, of the Durden Pine Co., Savannah, is President.

DELAWARE, LACKAWANNA & WESTERN.—An officer writes that this company is asking contractors to submit bids for building the proposed cut-off from Port Morris, N. J., on Lake Hopatcong, west to Slateford, Pa., on the Delaware river, 28.7 miles. For this main line cut-off the surveys have been made. It will save 11½ miles of distance, besides reducing grades and curves, and eliminating tunnels, of which there are two on the present line. (March 13, p. 395.)

GRAND TRUNK.—The tracks of the main line of this road are being relaid with 100-lb. rails on the section from Mille Roches, Ont., west to Cardinal, 33 miles. The rest of the line between Brockville and Montreal was relaid last year.

IDAHO NORTHERN RAILROAD.—An officer writes that this company, organized to build 76 miles of line in the Coeur d'Alene district, Idaho, for which contract was let last fall to the Pacific Coast Construction Company, of Portland, Ore., expects to begin track laying June 1. The line is being built from Enaville, Idaho, on the Wallace-Tekoa branch of the Oregon Railroad & Navigation Company, near Kingston, northeast to a point six miles east of Murray, 33 miles. Grading is about one-third finished, and it is expected the line will be ready for operation this year. Branches aggregating 43 miles are also to be built. B. F. O'Neill, President, Wallace, Idaho. W. P. Smith, Chief Engineer, Enaville. (April 10, p. 595.)

INTERBOROUGH RAPID TRANSIT.—This company, operating the subways and elevated lines of Manhattan, New York City, has sent to the New York State Public Service Commission a proposition looking to the construction by the Interborough of a subway from Flatbush avenue and Fulton street, Brooklyn, along Flatbush avenue extension to the Manhattan bridge (not yet finished), with a view to making a rapid transit line from the starting point across the bridge and thence to the Bowery and Canal street, Manhattan, where a connection can be made with the Third avenue elevated road. The Interborough offers to do the necessary construction for $1,200,000 and to operate the line under lease. The route of the proposed subway in Brooklyn is identical with a part of the Fourth avenue subway, for the construction of which the Public Service Commission has just let contracts; and the proposition of the Interborough seems to have been made on the assumption that these contracts will not be carried out for the reason that the city is not at present in a position to provide the necessary money.

MEXICAN ROADS.—A concession is reported granted by the federal government to General Julio M. Cervantes, of San Luis Potosi, to build 100 miles of railroad. The main line is to run from San Mateo, on the San Luis Potosi divisions of the Mexican Central, to Tiletla, with a branch to Tamazunchale.

Reports from Zacatecas state that a concession has been granted to Gustavo A. Madero, of Zacatecas, to build a line from Comacho, Zac., on the Mexican Central, east to Mazapil, 60 miles.

NEW YORK, CANADIAN & PACIFIC.—The bill extending the time for this company to build its road, projected since 1866, from New York City north to Canada, has been vetoed by the Governor of New York.

NEW YORK SUBWAYS.—The New York Public Service Commission, First district, recently let contracts for six sections of the Fourth avenue (Brooklyn) subway. In each case the contract was given to the bidder whose aggregate estimate on the cost of the railroad work and the pipe galleries was the lowest. The contracts are as follows:

Sec. No.	Location and bidder.	Railroad work.	Pipe galleries.	Total.
1.	Nassau to Willoughby streets; Jas. P. Graham	$1,020,476	$101,374	$1,121,850
2.	Willoughby street to Ashland place; William Bradley	3,436,019	58,695	3,494,714
3.	Ashland place to Sackett street; William Bradley	3,392,092	208,135	3,600,227
4.	Sackett street to 10th street; E. E. Smith Contracting Co.	2,283,533	206,672	2,490,205
5.	10th to 27th streets; Tidewater Building Co. and T. B. Bryson (joint bid)	1,945,640	251,076	2,196,716
6.	27th to 43d streets; E. E. Smith Contracting Co.	2,808,983	173,665	2,982,648
	Total	$14,886,743	$999,617	$15,886,360

The total of the awards for railroad work is $14,886,743 and for pipe galleries $999,617, making an aggregate cost for the six sections of $15,886,360. The beginning of work on these contracts must await action by the Board of Estimate and Apportionment on the question of providing funds.

NORTH MIDLAND (ELECTRIC).—The proposed route of this projected line is from London, Ont., north to St. Mary's, thence northeast to Stratford, 35 miles. A. E. Welch, 171 Dundas street, London, has a contract for some of the work, which is to be started as soon as the project is financed. There are to be two bridges. W. Scarlett, President, Princess avenue, London.

OHIO ELECTRIC RAILWAY.—The Lima & Toledo Traction Company, which is building a line from Deshler, Ohio, north to Toledo, 30 miles, has all the track laid from Maumee south to Waterville, and it is said that the approaches to the large concrete bridge near that place are about finished. It is expected that the company will begin operation to Toledo early in June. (March 27, p. 461.)

OKLAHOMA, EL RENO & SHAWNEE (ELECTRIC).—Incorporated in Oklahoma with $1,500,000 capital to build an electric line from Shawnee, Okla., west via Oklahoma City and Yukon to El Reno, 60 miles. It is estimated that it will cost $20,000 a mile to build the road. The incorporators include C. E. Huber, President; J. A. Niblo, W. M. Sawyer and S. L. Niblo, of Oklahoma City, and Charles E. Davis of Lugert.

OREGON EASTERN.—See Southern Pacific.

PENNSYLVANIA.—This company on May 24 put in operation the last section of its extensive improvements on the Conemaugh division, between Pittsburgh, Pa., and Johnstown. This marks the completion of the plans, begun in 1902, for a low grade line from Pittsburgh to the Atlantic ocean. With the exception of 24 miles on the west side of the Allegheny mountains and one mile near Freeport on the Conemaugh division, there is now a freight line with no adverse grade eastward of over 0.3 per cent. The work on the Conemaugh division required the excavation of 2,000,000 cu. yds. of material, the erection of 110,000 cu. yds. of masonry, and the piercing of a 760-ft. tunnel. Every grade crossing on the revised line has been eliminated. The company now has a low grade line parallel to the main line, from Pittsburgh to Johnstown; from Gallitzin, at the summit of the Alleghenies, to Petersburg, on the main line, and from Harrisburg, Pa., to Trenton, N. J., thus providing two distinct lines, one of two tracks and another of four, for about 261 miles out of the total of 388 miles from Pittsburgh to Trenton. This has been accomplished by double-tracking and revision on the Conemaugh division as before stated; by building an entirely new double-track line from Gallitzin to Hollidaysburg; double-tracking the branch line from Hollidaysburg to Petersburg; building a new double-track line from Harrisburg to Glen Loch, and revising the grades on the Trenton cut-off from Glen Loch to Morrisville. In addition it has been necessary to revise the grades and take out considerable curvature on the main line between Port Royal and Van Dyke and between Mount Union and Ryde. This latter work is almost but not quite finished. On the 24 miles from Johnstown to Gallitzin the ruling grade is 1 per cent. (March 13, p. 393.)

PENNSYLVANIA LINES WEST.—According to reports surveys are being made by the Pennsylvania company for a low-grade freight line from the Pittsburgh, Fort Wayne & Chicago at Enon, Pa., east to the Buffalo & Allegheny division of the Pennsylvania at Brady's Bend, about 50 miles. Such a line would enable the company to avoid sending much through freight through Pittsburgh.

RIO GRANDE, SIERRA MADRE & PACIFIC.—This company, which suspended work last year on the extension projected from Nueva Casas Grandes, Chihuahua, west to the Pacific coast, is reported to be preparing to resume work this fall. Grading has been finished from Nueva Casas Grandes south 25 miles, and rails are on the ground. A bridge has also been built over the Guerrero river. The proposed terminus is either Guaymas or Topolobampo. (Nov. 29, p. 669.)

SAN JUAN, TAVICHE & OAXACA.—An extension of two years from May 9, 1908, has been granted to C. A. Hamilton, of Oaxaca, to build this line. The projected route is from San Pablo Zimatlin, Oaxaca,

to the Taviche mining camp, about 17 miles. Most of the construction material is already on the ground. (April 3, p. 493.)

Southern Pacific.—The Oregon Eastern has finished surveys for a line from Natron, Ore., south to Klamath Falls, 152 miles. Surveys also made for a line from the Cascade Mountains east to the eastern boundary of the state at Ontario. The company recently had its charter amended so as to build a branch from Lakeview, Ore., south to the California state line, about 15 miles. It is the ultimate intention to further extend this line south through California. (March 13, p. 394.)

Sugar Creek & Northern.—See Wheeling & Lake Erie.

Terre Haute, Robinson, Olney & South-Western.—An officer writes that the route of this proposed line is from Terre Haute, Ind., southwest via Robinson, Ill., and Olney, to Mount Vernon, 125 miles, where connection is to be made with the Wabash, Chester & Western, running to the Mississippi river. It is the intention of the company ultimately to build an extension on the Missouri side of the Mississippi river, southwest about 60 miles. Contracts for some of the work has been let to Charles B. Duffy, St. Louis, Mo. The construction of the road depends upon the company's securing the necessary right of way within six months. There are to be steel bridges over the Wabash and Embarras rivers, and plate girders or concrete structures over other streams. Harris C. Pugh, President, Terre Haute, Ind. (May 8, p. 656.)

Texas & Pacific.—An officer writes in regard to improvements to be carried out by this company that the only work contemplated at the present time is laying heavier rails on 56 miles of the line.

Texas Northern.—An officer writes that this company's projected line is to run from Groveton, Texas, northeast via George, Apple Springs, Vair and Peavy to Lufkin, 36 miles. Grading has been finished and track laid on 23 miles. Bridgework and tracklaying is being done by the company's men. The Trinity County Lumber Company did all the construction work on the 23 miles between Groveton and Vair, at which point connection is to be made with the Texas South Eastern, over which the T. N. will have trackage rights to Lufkin, 13 miles. The Texas Northern will take over the railroad property of the Trinity County Lumber Company and operate it. P. A. McCarthy is Chief Engineer, Lufkin, Texas.

Texas Roads.—According to reports from Port Arthur, Texas, John W. Gates, of New York, is arranging to finance two projects to build new lines in Texas. One of the proposed lines is to run from Port Arthur north to Waco, about 225 miles, and the other from Port Arthur, west to Houston, about 90 miles. Some construction work has already been done on the latter, and it is said that work on the Port Arthur and Waco line is to be started this fall and pushed to completion. R. C. Duff, of Beaumont, is interested.

Trinity Lumber Company's Railroad.—See Texas Northern.

Union Pacific.—According to reports from Colorado, this company is planning to build a branch from Platteville, Colo., northwest to Fort Collins, about 35 miles.

Vancouver Island & Eastern.—A director of this proposed line states that the charter authorizing it to build has been passed by both the House of Commons and the Senate, but has not yet been signed by the Governor-General. The organization of the company is not yet complete. The proposed route is from Vancouver Island, northeast through British Columbia to Edmonton, Alb. H. A. Munn, Victoria, B. C., and James Smith, Edmonton, Alb., are among the provisional directors. (March 1, p. 624.)

Wheeling & Lake Erie.—An officer writes that work has not been resumed, as stated in recent reports, on the new cut-off of the Sugar Creek & Northern from Bolivar, Ohio, northwest to Orrville, 22 miles. At the time work was stopped three-fourths of the grading was finished and track laid on about eight miles. (March 13, p. 395.)

RAILROAD CORPORATION NEWS.

Alaska Central.—John F. Goodwin has been appointed Receiver of the Alaska Central and the Tanana Railway Construction Co.

Atlanta & Carolina (Electric).—This company has filed a mortgage securing $6,000,000 5 per cent. 30-year bonds of 1908-1938. This is a projected electric road between Atlanta, Ga., and Augusta, 160 miles.

Atlantic Coast Line.—A semi-annual cash dividend of 2 per cent. on the common stock was declared on May 21. The dividend last January was 3 per cent., but was paid in Atlantic Coast Line 4 per cent. certificates of indebtedness.

Chesapeake & Ohio.—Kissel, Kinnicutt & Co., and Moffat & White, of New York, are offering $2,000,000 first consolidated 5 per cent. mortgage bonds of the Chesapeake & Ohio at 112, yielding 4.30 per cent. The bonds were sold by the railroad company to provide for refunding first mortgage 6 per cent. bonds maturing July 1, 1908.

Chicago, Burlington & Quincy.—J. P. Morgan & Co., of New York, have sold $16,000,000 general mortgage 4 per cent. 50-year bonds of 1908-1958, at 95½. This is part of a total authorized issue of $300,000,000 secured by a mortgage dated March 2, 1908. The proceeds of the sale are to be used to repay the railroad company for money spent on improvements and acquisitions.

Chicago, Milwaukee & St. Paul.—On May 16 the train service between Chicago and Evanston, Ill., was cut down to two trains a day each way. The line north of Sheridan Park (Wilson avenue), is operated by the Northwestern Elevated, with through service between the loop and all stations north of Wilson avenue.

Maine Central.—Lee, Higginson & Co., Kidder, Peabody & Co., R. L. Day & Co., and Estabrook & Co., of Boston, Mass., are offering the unsold portion of $2,119,000 first mortgage, 4½ per cent. 20-year bonds of 1908-1928 of the Portland & Ogdensburg. These bonds are guaranteed by the Maine Central. The bonds are offered at 104¾, yielding 4.15 per cent.

Missouri, Kansas & Texas.—H. W. Poor & Company, of New York, are offering a block of the first and refunding mortgage 4 per cent. bonds of the Missouri, Kansas & Texas at a price to yield 5.35 per cent. The total outstanding of these bonds is $5,182,000.

New York & Long Island.—The Frawley bill giving the Public Service Commission, Second district, and the Board of Estimate authority to buy for the state, the Belmont tunnel which runs under the East river from Forty-second street to Long Island City, L. I., has been signed by the Governor of New York. The Court of Appeals of New York recently handed down a decision sustaining the validity of the franchise of the New York & Long Island to build and operate this tunnel. (May 22, p. 718.)

New York Central & Hudson River.—William A. Read & Company, of New York, are offering $150,000 stock of the Beach Creek Railroad, 4 per cent. dividends being guaranteed by the New York Central & Hudson River. This stock is offered at 96, yielding 4.20 per cent.

New York, New Haven & Hartford.—A bill in equity to restrain the New York, New Haven & Hartford from exercising any control over the Boston & Maine, and to separate from the New Haven road its trolley properties was filed in the U. S. Circuit Court in Boston on May 22. The suit was brought under the Sherman Anti-Trust Law and the railroad company has 30 days in which to file an answer. (Note page 720.)

The New York State Public Service Commission, Second district, has forbidden the use of soft coal by the engines of the New York, New Haven & Hartford at the Harlem River terminal yard.

Pennsylvania Lines West.—The Pittsburgh, Youngstown & Ashtabula has authorized a $15,000,000 4 per cent. bond issue. The proceeds from the sale of these bonds are to be used in paying off prior lien bonds and making improvements.

San Francisco, Oakland & San Jose Consolidated (Electric).—The shareholders have authorized a consolidated mortgage to secure $7,500,000 bonds of which $4,500,000 are to be reserved to meet the present debt on the old San Francisco, Oakland & San Jose Railway, consisting of $3,000,000 first mortgage and $1,500,000 second mortgage 5 per cent. bonds due 1933.

Seaboard Air Line.—A syndicate managed by the National City Bank of New York has purchased $3,000,000 three-year 6 per cent. receiver's certificates of June 1, 1908. The proceeds of this sale are to provide for the interest payments on underlying bonds and to pay interest and principal on various car trusts, and for certain new construction and other purposes.

Southern Pacific.—E. H. Harriman is said to have obtained control of the Ocean Shore railroad concession. The Ocean Shore holdings include a right of way through San Francisco.

Underground Electric of London.—Secretary W. E. Mandelick announces that the holders of over 90 per cent. of the 5 per cent. profit sharing notes have deposited their notes and assented to the plan of readjustment. The company will, therefore, proceed with the readjustment as outlined in the plan dated April 14, 1908, and published by Speyer & Co.

United Railways of St. Louis—The United States Supreme Court on May 18 handed down a decision sustaining the rights of the city of St. Louis, Mo., to levy a tax of one mill per passenger on the street railways. This ordinance, which went into effect January 1, 1904, succeeds an ordinance in which the city collected a license fee of $25 per car per year. The amount of back taxes due is about $850,000.

Western Maryland.—The Mercantile Trust Co. will sell at public auction on June 9 all but seven shares of the stock of the George's Creek & Cumberland, which stock was pledged with the trust company by the Western Maryland to secure a note of $1,101,875. The par value of the stock is $999,600.